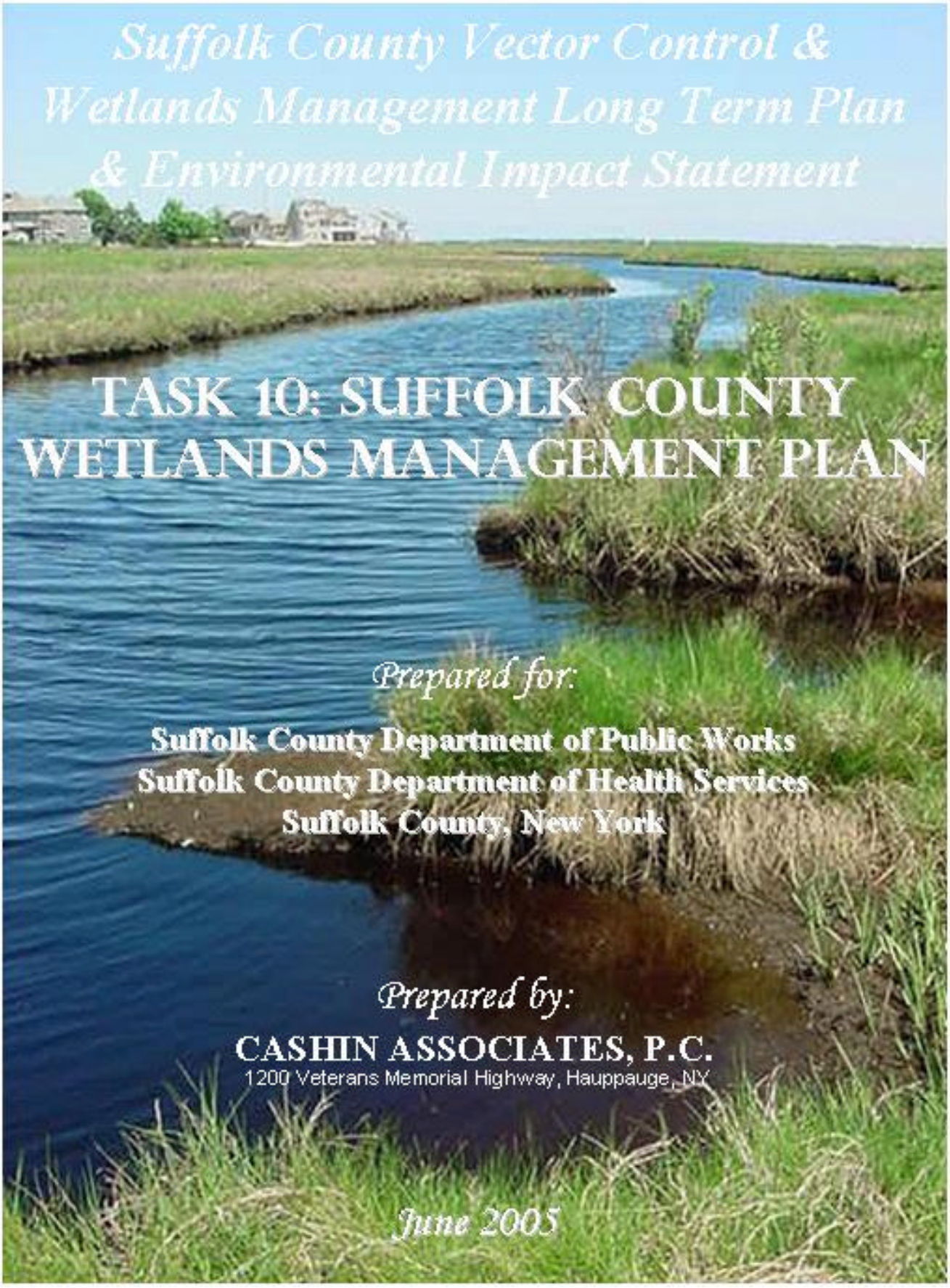
Appendix 1 – Wetlands Management Plan



Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

TASK 10: SUFFOLK COUNTY WETLANDS MANAGEMENT PLAN

Prepared for:

Suffolk County Department of Public Works
Suffolk County Department of Health Services
Suffolk County, New York

Prepared by:

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June 2005

SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT

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Table of Contents

Tables

Figures

Appendix

Acronyms and Abbreviations

BMP	Best Management Program
IPM	Integrated Pest Management
LISS	Long Island Sound Study
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
OMWM	Open Marsh Water Management
PEP	Peconic Estuary Program
SCDHS	Suffolk County Department of Health Services
SCDP	Suffolk County Department of Planning
SCDPSC	Suffolk County Dredge Project Screening Committee
SCVC	Suffolk County Vector Control
SSER	South Shore Estuary Reserve

EXECUTIVE SUMMARY

Abstract

Over a 12 year period, Suffolk County plans to address the vector control and ancillary wetland management needs for all 17,000 acres of tidal wetlands in Suffolk County. The approach of major marsh restoration, natural reversion, and other best management practices will be a radical departure from the current program of maintenance of the legacy grid ditch water management system.

Progressive water management will be implemented in over 4,000 acres of tidal wetlands that have been identified as mosquito breeding problem areas. The goals of this initiative are pesticide reduction and habitat enhancement, including maintaining or increasing biodiversity and *Phragmites* control. It is estimated that approximately 4,000 acres of tidal wetlands will undergo reversion, because of low mosquito breeding potential and/or distance from points of dense populations of people. In those areas, natural processes will gradually undo the construction of ditches across the marshes. In the long run, reversion is not necessarily ecologically optimal; other restoration options may need to be considered for purposes other than vector control.

The remaining 9,000 acres will be assessed over the coming decade, with some being actively restored, and others subjected to reversion processes. The policy in these areas will be one of presumptive interim reversion (i.e., no ditch maintenance unless deemed necessary for ecological or mosquito control purposes). It is expected that less than four percent of the County's tidal wetlands (less than 600 acres) will be subject to ditch maintenance over the next decade.

Ditch Maintenance Policy

Suffolk County has inherited a legacy of approximately 17,000 acres of tidal wetlands which have been fundamentally altered. In the 1920s and 1930s, these tidal wetlands were substantially grid-ditched, in an effort to remove stagnant water and mosquito-breeding habitat. Natural features, such as ponds and pannes, were affected in many settings, and biological communities in the wetlands were altered.

The Wetlands Management Plan represents a significant departure from seven decades of grid-ditch maintenance policy. Instead of committing to maintain the grid ditch network as a means of controlling mosquitoes, Suffolk County will instead apply more nuanced criteria to determine the best means of managing its salt marsh resources. For now, plans include a presumptive policy of reversion, where wetlands that pose no mosquito problems will remain untouched while long-term plans for restoration are

developed and implemented. Existing water management systems (ditches, culverts, and other structures) will normally be either left alone, if not needed for mosquito control, or upgraded to BMPs as outlined in the Plan. In some cases, implementation of BMPs is not immediately feasible due to lack of pre-project information or institutional factors such as landowner policies. Implementation of BMPs may also not be immediately feasible due to lack of resources. For instance, if major tidal flow restoration is desirable but is currently too expensive because it involves major road work, interim measures should be taken while these resources are sought if the alternative is a loss of habitat and/or an increased reliance on pesticides.

Assuming Long-Term Plan water management policies are implemented (especially open marsh water management), the general presumption will be against maintenance of ditch systems. However, in limited circumstances, existing structures may be maintained on an interim basis, when the following conditions are met:

- Deterioration of or damage to structures is resulting in a significant mosquito problem, as evidenced by larval and/or adult surveillance, serious enough to require control. An example would be a collapsed pipe that restricts tidal flow and results in a need to larvicide an area. Or:

- Failure to maintain the structures would result in the loss of resource values, such as fish passage or tidal flow, or loss of vegetation due to freshwater impoundment. Or:

- Failure to maintain the structures would result in a hazard or loss of property as a result of flooding.

Benefits to be expected from the work include:

- Maintaining or reconstructing the existing structures will improve water circulation or provide fish habitat sufficient to reduce the need for pesticide application.

- Maintaining the structures is compatible with habitat values that existed prior to the failure or deterioration of the structures.

- Maintaining the structure will prevent flooding or other hazards.

Constraints on any maintenance of a pre-existing ditch system include:

- The structures will be maintained essentially in-place and in-kind.

- Disruption of wildlife habitat due to construction will be minimized by limiting work areas and/or by using seasonal constraints.

- Listed species will not be adversely impacted.

- Interim maintenance will not lead to excessive drainage that would result in a loss of wetlands values.

- The action will not lead to increased or more direct conveyance of inputs from storm drains or other structures.

- The action will not preclude the implementation of BMPs when resources and/or institutional considerations allow.

Given the above, it is expected that less than 50 acres per year will be subject to ditch network maintenance. All maintenance will be summarized in the annual water management reports, and will be conducted in accordance with a MOU with the SCDHS Office of Ecology.

Progressive Water Management (OMWM)

The proposed policy change is predicated on the ability to conduct a broad variety of best management practices and, specifically, to implement the kinds of progressive water management that are often labeled as OMWM. All mosquitoes spend larval stages as aquatic organisms, and source reduction is an essential component of mosquito control as practiced through IPM. Source reduction through OMWM leads to impressive reductions in successful mosquito breeding, and so leads to major reductions in the number of applications and overall usage of pesticides. In addition, this kind of water management also increases overall marsh habitat diversity and wildlife values.

This holistic approach has successfully been demonstrated for the first time on Long Island, as part of this Wetlands Management Plan, at the Wertheim National Wildlife Refuge. Permitting of this project was a major accomplishment, in that it overcame concerns raised by State regulators regarding potential impacts to existing important natural resource attributes of ditched marshes, and marsh loss in tidal settings, together with a lack of monitoring and documentation for past OMWM demonstration projects. The degree to which project plans addressed these concerns coupled with the first blush of success at the site in controlling mosquito breeding and enhancing natural resource values may allow NYSDEC to consider these options that might not have passed regulatory muster a short while ago. Continued cooperation

between federal and state agencies will be critical to ensure that projects similar to Wertheim will be implemented throughout Suffolk County.

Wetlands Management Plan Approach

The Wetlands Management Plan consists of seven sections, the first of which addresses goals and numerous objectives. In the second section, a framework for managing larger, more ambitious projects is discussed. A key feature is the creation a Screening Committee to review and approve the major projects.

In section three, the 15 Best Management Practices and four Interim Management Actions are discussed. The actions are aimed at reducing mosquito populations utilizing methods that either minimizes potential environmental change, or maximizes the enhancement of particular natural resource values.

Section 4 and Section 5 of the Wetlands Management Plan address plan implementation and resource needs of SCVC to undertake this Wetlands Management Plan, respectively. The need for streamlined and dedicated State processes is highlighted. Vector control program needs may be eligible for restoration grant opportunities, as well as the Suffolk County Water Quality Protection and Restoration Program (the Quarter Percent Sales Tax). Section 6 establishes a Timeline for reaching Wetlands Management Plan goals, and in Section 7 the County's salt marshes are prioritized in terms of those requiring restoration to address mosquito management needs, sites that appear to be best suited for reversion, and those areas requiring closer study before determining overall management needs.

Freshwater Wetlands

In New York State, fresh water regulations do not allow for much manipulation of the existing hydrology of the marshes. This means that there are very few options in terms of mosquito-related water management and restoration. Source reduction and larviciding are the main means of addressing mosquito problems associated with freshwater wetlands (see above and below).

Underlying Data and Interagency Approach

This plan is based on tremendous amount of collaboration among agencies within the Wetlands Subcommittee. It is also the result of an exhaustive literature review and comprehensive field work, which is reflected in Task 3 (Literature Review) and Task 7 (21 representative wetland areas, totaling over 2,000 acres, have been evaluated in detail). The first digital tidal wetlands map, for all County wetlands, has been produced, and the Remote Sensing project is expected to provide a continuing and cost-effective means to implement the long-term program.

1 GOALS AND OBJECTIVES

1.1 Introduction

A public policy plan requires a clear statement of the purpose and intent of the plan. This is necessary for many reasons. Among them are:

- To provide overall guidance for technical managers
- To underscore key issues for those setting governmental directions
- To clearly explain to the interested public the intent of the proposal

The Long-Term Plan requires a water management component. This is because modern mosquito management follows the tenets of Integrated Pest Management (IPM). IPM requires that all actions be commensurate with the problem at hand, and establishes a general hierarchy for acceptable pest control. In this hierarchy, source control is always preferred over pesticide use.

For mosquito management, source control entails taking steps to make the environment less hospitable for mosquitoes. Because mosquitoes are concentrated as larvae, and then disperse to some degree as adults, it is eminently more practical to try to control immature mosquitoes. These larvae require still, shallow, generally impermanent water bodies to develop, which means wetlands are often important mosquito sources. Therefore, larval mosquito control requires managing these wetland habitats to minimize mosquito breeding potential.

New York State Department of Environmental Conservation (NYSDEC), generally but not entirely, does not allow alteration of fresh water wetlands. The Long-Term Plan will identify reconsideration of the policies and regulations that result in this determination as a priority for future action; however, this means the focus of mosquito source control is on water management activities in salt marshes.

For more than 100 years, ditching marshes and then maintaining those ditches has been the most common means of water management in the northeast US. More progressive means of water management have been developed and adopted by other jurisdictions. However, New York State

has conservatively determined (in the Tidal Wetlands Land Use Regulations) that ditch maintenance is generally compatible with its goals for salt marshes, but that other measures require proof that they will not cause damage to these resources. This has limited the use of alternative means of water management heretofore.

However, it is clear that these more progressive means of water management hold the promise of helping the County achieve several objectives at once: to significantly reduce the amount of larviciding needed for persistent mosquito breeding, and to enhance the natural resource qualities associated with the County's salt marshes. For that reason, it is envisioned that the implementation of this plan will emphasize water management techniques other than ditch maintenance. This should result in the implementation of progressive water management projects designed for long-term management of the marshes.

The initial work conducted in developing the Long-Term Plan will assess and provide recommendations for approximately 2,000 acres of the 17,000 acres of salt marsh within Suffolk County. The recommendations for action will begin by determining if a mosquito problem exists at a particular marsh or not. The default action in terms of vector control, where no problem exists, is to take no action – allow the marsh to follow natural processes. There may be other reasons for restoring the marsh, and it may be the case that Suffolk County Vector Control (SCVC) is the agency best suited to lead that restoration. Nonetheless, for many salt marshes, from a vector control standpoint, no action will be necessary.

Responses where mosquito problems are determined to exist will be selected on the basis of appropriateness to the degree of the problem. Specific criteria for actions will be determined in the Best Management Practices (BMP) manual, which is attached to this plan. Generally, marshes with small breeding areas or relatively good existing marsh quality will not receive major restoration efforts, while those that have a great deal of mosquito habitat or where the marsh is degraded or degrading would receive a larger response.

The Long-Term Plan envisions that approximately 4,000 acres of salt marsh will quickly be assessed as requiring no water management, for various reasons. Approximately the same amount of acreage will be initially evaluated as requiring progressive water management, due to current status as a site receiving aerial application of larvicides. The remainder of the County's

wetlands will be assessed to determine appropriate management by 2015. Implementation of plans will take a little more time, but we are hopeful construction can be completed everywhere it is warranted by 2017. Over the interim period, the presumptive policy of the County for its wetlands is one of non-intervention in wetlands process, allowing for marsh reversion.

The Long-Term Plan intends to provide resource agencies with the kind of information that will allow them to view the to be proposed approaches to water management more favorably, and to allow the County to implement more progressive means of controlling mosquito problems without the use of chemicals. However, it is likely, if the Long-Term Plan is to clearly endorse water management and reduce chemical applications, as it should according to IPM, that some amount of well-designed, selective maintenance of the existing ditch network will be required as an interim measure. Ditch maintenance will only occur under well-defined conditions, with the intent of the on-going ditch maintenance being, primarily, to improve water quality and generally support *Fundulus spp.* habitat in the vicinity of excessive mosquito breeding. Existing water management systems (ditches, culverts, and other structures) will normally be either left alone, if not needed for mosquito control, or upgraded to BMPs as outlined in the Plan. In some cases, implementation of BMPs is not immediately feasible due to lack of pre-project information or institutional factors such as landowner policies. Implementation of BMPs may also not be immediately feasible due to lack of resources. For instance, if major tidal flow restoration is desirable but is currently too expensive because it involves major road work, interim measures should be taken while these resources are sought if the alternative is a loss of habitat and/or an increased reliance on pesticides.

Assuming Long-Term Plan water management policies are implemented (especially open marsh water management), the general presumption will be against maintenance of ditch systems. However, in limited circumstances, existing structures may be maintained on an interim basis, when the following conditions are met:

- Deterioration of or damage to structures is resulting in a significant mosquito problem, as evidenced by larval and/or adult surveillance, serious enough to require control. An example would be a collapsed pipe that restricts tidal flow and results in a need to larvicide an area. Or:

- Failure to maintain the structures would result in the loss of resource values, such as fish passage or tidal flow, or loss of vegetation due to freshwater impoundment. Or:

- Failure to maintain the structures would result in a hazard or loss of property as a result of flooding.

Benefits to be expected from the work include:

- Maintaining or reconstructing the existing structures will improve water circulation or provide fish habitat sufficient to reduce the need for pesticide application.

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- Maintaining the structure will prevent flooding or other hazards.

Constraints on any maintenance of a pre-existing ditch system include:

- The structures will be maintained essentially in-place and in-kind.

- Disruption of wildlife habitat due to construction will be minimized by limiting work areas and/or by using seasonal constraints.

- Listed species will not be adversely impacted.

- Interim maintenance will not lead to excessive drainage that would result in a loss of wetlands values.

- The action will not lead to increased or more direct conveyance of inputs from storm drains or other structures.

- The action will not preclude the implementation of BMPs when resources and/or institutional considerations allow.

Given the above, it is expected that less than 50 acres per year will be subject to ditch network maintenance. All maintenance will be summarized in the annual water management reports, and

will be conducted in accordance with a Memorandum of Understanding with the SCDHS Office of Ecology.

Such interim practices may be perceived as being in conflict with certain other planning guidances, such as the Peconic Estuary Program (PEP) Comprehensive Conservation and Management Plan proposal to stop the maintenance of existing mosquito control ditches. However, the PEP plan also stresses the need for reduced pesticide applications, and espouses IPM. IPM, as discussed above, calls for source reduction before pesticide use, which means that if mosquito populations are to be controlled using IPM, water management needs to be favored before pesticide applications. Until more progressive means of water management are allowed by NYSDEC, and identified by the Management Plan process, some water management will need to be addressed through interim measures that will tend to rely on standard practices involving selective, targeted maintenance of the existing mosquito ditches.

1.2 Principles

In order for Suffolk County, particularly SCVC, to properly prioritize its wetlands management efforts, it is necessary to develop some overarching goals, and to set associated achievable objectives that will allow SCVC to meet these goals. These goals are to be identified under two guiding principles. SCVC should always act so as to preserve public health and well-being for all citizens. Secondly, SCVC should maintain and, where possible, enhance the Suffolk County environment. This can be best achieved through an IPM program, where actions taken are commensurate with the detected problems, and are selected so as to cause the least harm and reap the greatest benefits in terms of curbing the pest problem.

These goals and objectives will need to be reconsidered, reworked, and reaffirmed at set intervals. This will allow knowledge gained through better understanding of the wetlands systems, and experience from implementing the various management techniques, to be incorporated to improve the overall Wetlands Management Plan.

1.3 Scope

This document will focus on salt marshes and associated upland freshwater wetlands. This is because active water management in freshwater habitats for mosquito control is generally

precluded under State wetlands regulation. The exceptions to that general prohibition would be the maintenance and potential modification of structures such as culverts and existing ditches, and activities associated with stormwater control that are proposed as part of compliance with US Environmental Protection Agency Phase II Stormwater rules. Phase II Stormwater compliance activities are unlikely to result in much freshwater wetlands modification, manipulation, or creation on Long Island, although this is not the case elsewhere. Insofar as any Phase II actions do impact existing wetlands, however, it is anticipated that SCVC will be asked to review the plans, in which case the goals and objectives established here will serve as guiding principles for those reviews.

Nonetheless, it should be a goal for SCVC to continue discussions with NYSDEC to determine if there are ecologically sound techniques that can be implemented, at some future time, in order to reduce the application of pesticides for mosquito control in fresh water environments.

1.4 Goals

When conducting water management, SCVC is to consider the following overlapping and yet hierarchical set of goals:

1) reduce mosquito populations

2) preserve or increase acreage of (coastal) wetlands, including vegetated (tidal) wetlands, and to foster (marine and estuarine) biodiversity and a mosaic of ecological communities

3) control *Phragmites* and other invasive plant and animal species

Attaining these three goals will preserve public health and well-being while enhancing environmental conditions within the County.

It is clear that to achieve the foster of biodiversity and enhance the general mosaic of ecological communities in many salt marsh settings (the second goal, above), invasive *Phragmites* will need to be addressed (the third goal). However, certain means of controlling *Phragmites* may result in unacceptable collateral ecological impacts. Therefore, the control of *Phragmites* is secondary to the fostering and preservation of other desired environmental features.

The reason for the existence of SCVC is the need to control mosquito populations and to minimize any associated disease risks, in the service of the protection of health and public well-being. Therefore, it is clear that mosquito control must always be a factor in any action undertaken by SCVC. SCVC has long recognized that mosquito control, not extermination of mosquitoes, was its mission. That is, it is not possible, necessary, or even desirable to eliminate mosquitoes from the landscape. As we enter the 21st century, advances in mosquito control and wetlands management techniques open the possibility that SCVC can not only operate to protect the public from mosquitoes, but that it can often accomplish this work while achieving desired environmental ends.

In fact, its long history of operations in wetlands and its array of specialized equipment and expertise place SCVC in a unique position among wetlands stakeholders. While many agencies have an interest in wetlands management, only SCVC has in-house and fully funded abilities, and an associated mandate, to maintain and restore wetlands throughout the County.

Good mosquito control and proper natural resource management are convergent principles for SCVC in almost all of its operations. In some settings and at some times, however, some facets of public health protection may conflict, to one degree or another, with absolute preservation of all aspects of the natural world. At those times, insofar as environmental issues can be determined to be secondary to human health concerns, it may be necessary for SCVC to act so as to reduce mosquito populations despite impacts to wetlands and their associated ecological communities. However, while the goal of reducing mosquito populations can be understood as the highest goal for SCVC, its unique place in County wetlands management gives it special responsibilities to act, whenever possible, to enhance resource values and to minimize instances of unavoidable, adverse impacts.

A tenet of IPM is that source reduction is preferable to the use of chemicals. In addition to environmental concerns, an excessive reliance on pesticides can leave a control program vulnerable to resistance, poor application conditions, loss of materials in the marketplace and other factors that can prevent control with these materials. For Integrated Mosquito Management, this has been interpreted that water management is preferred as a management tool to the use of larvicides and adulticides. Water management is often more difficult to implement

than pesticide use. It can be more difficult in terms of having greater initial costs (for equipment and manpower), requiring greater and more technical environmental monitoring, having more permitting and other regulatory requirements, and often needing cooperation and assistance from organizations other than SCVC, among other issues. Thus, water management generally requires endorsements from the managers of the mosquito control agency and area natural resource agencies for projects to be considered. Water management often involves structural changes to natural systems; alterations to such complex systems can lead to unforeseen results. That this can occur can make some involved parties reluctant to allow such projects to be undertaken. However, water management also has the potential to have continuing impacts on mosquito populations, often with little to no operational costs, to have these effects with little or no collateral environmental impacts, and to achieve auxiliary environmental benefits such as a greater mosaic of ecological communities, improved biodiversity, and even reduced *Phragmites* incursions. These projected benefits, and the measurable benefits achieved in other municipalities with active, progressive water management programs, have led SCVC to embrace the concept of modern water management, as developed in the project water management (BMP) manual.

In Suffolk County, nearly all tidal wetlands were grid ditched in the 1930s for mosquito control. In addition, wetlands have been altered or manipulated in a variety of ways by other interests. Wetlands have been completely or partially filled, and waterways have been altered by dredging. A particularly important problem is the restriction of tidal flow to many wetlands as a result of road and other construction projects, so that in many cases ditches and culverts provide the little tidal flow that reaches these degraded wetlands. SCVC has the responsibility for maintaining these structures. The legacy of these hydrological alterations is that many wetlands will degrade further without continuing maintenance or management of these water control structures. A major part of the overall water management strategy is to determine the best means to address past practices in ways that will maintain or even enhance these altered systems.

1.5 Objectives

The following are meaningful and quantified objectives that will assist SCVC in achieving its overarching goals, by means of the stated principles.

Goal 1: Reduce Mosquito Populations

- Objective 1: salt marsh mosquito populations will be maintained at 1996-2004 levels, as measured in New Jersey light traps.

- Objective 2: the number of days that complaints associated with salt marsh mosquitoes are received will not increase despite anticipated changes in population densities and development patterns near salt marshes.

- Objective 3: control of important bridge vector mosquitoes will continue to reduce the risk of mosquito-borne disease below levels experienced in jurisdictions lacking these efforts.

- Objective 4: approximately 4,000 acres of marsh will be made more amenable for insectivorous fish populations.

Goal 2: Preserve or increase acreage of coastal wetlands, including vegetated tidal wetlands, and to foster marine and estuarine biodiversity and a mosaic of ecological communities

- Objective 1: salt marsh management will be conducted so as to provide overall habitat diversity, generated by a mosaic of tidal creeks, ponds, low and high marsh, pannes, mudflats, salt shrub, associated freshwater wetlands, and adjacent beaches or sand berms (although every marsh may not have all habitats), providing a variety of microhabitats and ecotones, which should support appropriate plant and animal diversity, as measured by monitoring and project evaluations.

- Objective 2: there will be no net loss of vegetated tidal wetlands in Suffolk County

- Objective 3: major salt marsh restorations of at least 50 acres will have the goals of restoring significantly degraded systems and limiting larvicide applications to extreme, unforeseen circumstances.

- Objective 4: generally, marsh management will be conducted with the intent of eliminating routine applications of larvicides for salt marsh mosquito control, so

as to result in drastic reductions in the acreage of larvicide treatments, on the order of 33 percent over the first five years, and 75 percent over ten years (assuming regulatory cooperation so as to allow implementation of the necessary projects).

- Objective 5: similarly, adulticide use to control salt marsh mosquitoes will be reduced, in terms of application frequencies and acreage treated, as a result of the more effective control measures associated with progressive water management.

- Objective 6: vector control initiatives will be integrated by SCVC with other initiatives having more general marsh restoration aims, which are sponsored or proposed by organizations such as the Long Island Sound Study, the Peconic Estuary Program, the South Shore Estuary Reserve, State agencies, Towns, and other organizations.

- Objective 7: SCVC will use its position as the major County salt marsh manager to influence other County departments and organizations to take steps to improve salt marsh conditions, including (but not limited to) permit issuance, appropriate controls of storm water, land use considerations, and shoreline and marine activities such as dredging.

Goal 3: Control *Phragmites* and other invasive species

- Objective 1: where *Phragmites* expansion has been determined to occur, enhancement of salt water circulation will be a design priority.

- Objective 2: all major marsh restoration projects (50 acres or more) will necessarily include *Phragmites* control as a design element.

- Objective 3: county-wide, by 2017 the percentage of acres of salt marsh dominated by *Phragmites* will have decreased.

2 OPERATIONAL STRUCTURE

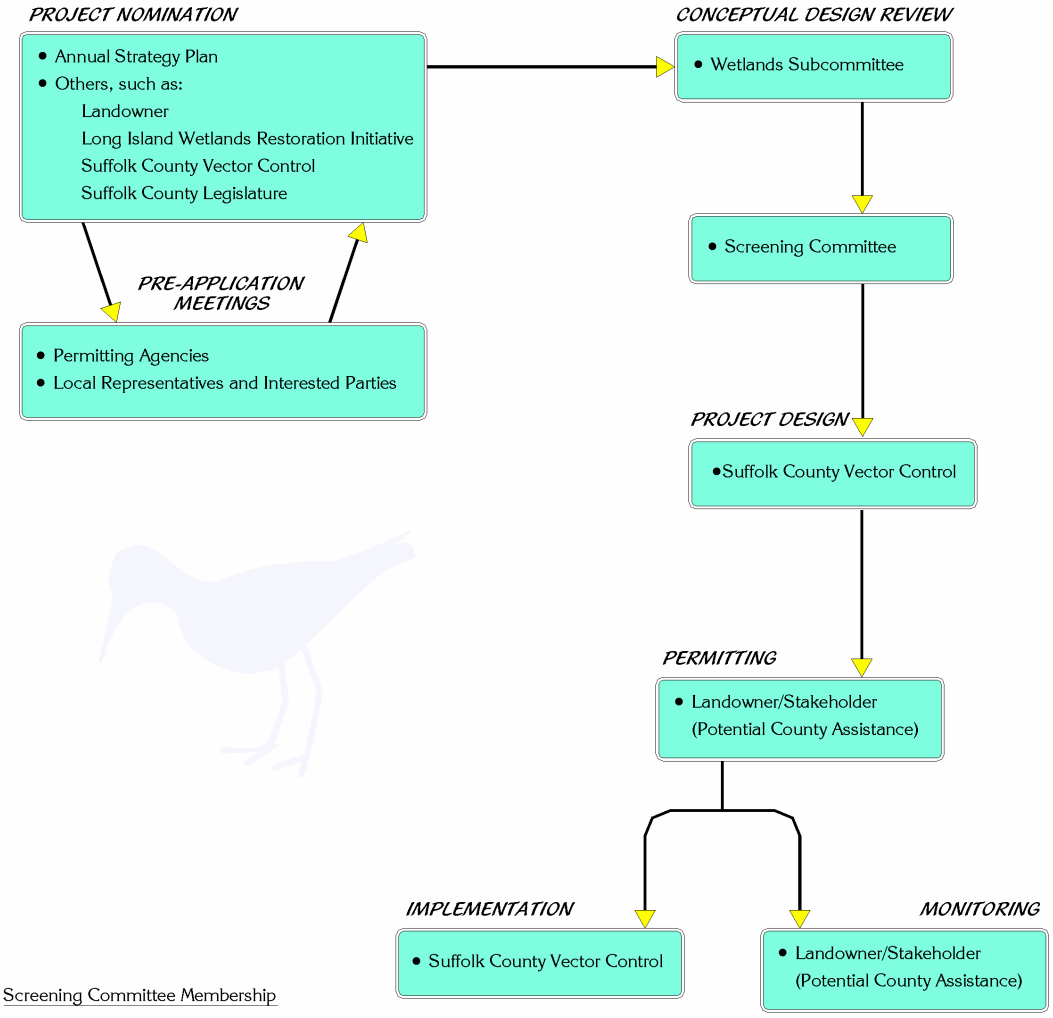
Salt marsh management projects that will be addressed by SCVC must undergo thorough evaluation to ensure that the project:

- is in agreement with the goals and objectives of the County Wetlands Management Plan
- is well-designed
- is environmentally sound
- can be implemented under current permitting requirements and strictures

Many projects that are small and/or use management techniques that should have minimal impacts do not need to be as formally evaluated as other projects. It is, of course, assumed that these projects conform to the Annual Plan of Work and the Wetlands Management Plan. For projects that are smaller than 15 acres in size, and employ the BMPs described as "No to little impact" or "Minimal impact" (see Section 3, below), SCVC will consult with NYSDEC and appropriate officials in the municipality where the project is located. SCVC will thoroughly explain the project intent and the means by which it will be conducted. NYSDEC and the municipal officials will provide any needed feedback, and, if any permits are required, they will be acquired. Generally, specific, cooperative agreements will be sought with each municipality to ensure that a procedure is in place that allows for municipal comfort with the degree of coordination to be provided by SCVC, without burdening either the County or the municipality with unneeded oversight responsibilities. If landowner approval and cooperation was not obtained through the project identification process, it will be obtained prior to initiation of any work (this need may be obviated when there is an imminent threat to public health and welfare). The project description will include a discussion of the measurement of project success, and any monitoring program that may be deemed to be appropriate.

Major projects will not be so simply managed. A process diagram (Figure 1) is included that sketches out how major projects will be evaluated in order to address the four issues listed above.

SUFFOLK COUNTY WETLANDS SCREENING COMMITTEE FOR INDIVIDUAL MAJOR RESTORATION PROJECTS



Screening Committee Membership

Suffolk County Executive Appointees: (3)

- Commissioner, Suffolk County Department of Planning
- Commissioner, Suffolk County Department of Public Works
- Commissioner, Suffolk County Department of Health Services

New York State Governor Appointees: (2)

- Director, Region I, New York State Department of Environmental Conservation
- Director, Division of Coastal Resources, New York State Department of State

Suffolk County Legislature Appointees: (3)

- Presiding Officer Representative
- Citizen Representative

Towns / Trustees

- Representative, based on project location

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FIGURE 1
WETLANDS
MANAGEMENT PLAN

In addition, any ditch maintenance project (in particular) will be reviewed by SCDHS Office of Ecology for potential environmental impacts, SCVC will be required to address concerns and issues raised by local agencies so as to reach agreement on the appropriateness and scope of the project.

2.1 Project Nomination

The initial step is the identification of a potential project. It is anticipated that many if not all major projects will be identified through the creation of an Annual Strategy Plan by SCVC, in cooperation with the Long-Term Plan Wetlands Subcommittee. The Annual Strategy Plan will be developed each spring (say, from April 15 to June 15). It will contain a plan for SCVC to move forward to address the Goals and Objectives of this Wetlands Management Plan, generally. In order to achieve that, it will contain three specific sections. They are:

1) marshes that have been prioritized for assessment, and the assessment methodology, to determine the appropriate BMP for the marsh

2) minor water management conducted in the previous year, and projected minor water management actions for the next year

3) marsh-wide projects scheduled for the next three years (some of which will not meet the definition of major projects, as defined above)

The list of marshes to be assessed, which is the initial step in identifying a major project, will be developed in several ways. One way is for the marsh to be a priority site for SCVC, due to identified mosquito control issues. Another is for the landowner to nominate the marsh. In most cases, where the County is not the owner of the marsh, SCVC (or the local municipality) may try to persuade the landowner to formally propose the project. In those cases, although the project was initially identified by SCVC and perhaps further identified by the local municipality as a potential project, when the landowner formally nominates the project, it becomes the overall responsibility of the landowner.

Other third parties may nominate a site. Instances of this include promptings by organizations such as the Long Island Wetlands Restoration Initiative or some other non-governmental agency, or a legislator, or a department of the County other than SCVC. In many cases, these third parties may approach the landowner to persuade the landowner to take on the project. In other cases, the third party may approach SCVC, and try to persuade SCVC to undertake sponsorship. Finally, the third party may determine it has enough resources to sponsor the project directly.

In cases where the landowner is not the sponsor, landowner permission to proceed must be obtained early in the process. This may not be the first step made by the sponsor – certain feasibility tests, either through site observations or measurements, or initial contacts to sound out permitting and/or funding agencies may be tried before such a contact. However, one of the first tests by the Screening Committee will be to receive proof of the landowner's acquiescence in the project.

If SCVC is not the project sponsor, it behooves the project sponsor to approach SCVC to gauge the interest and ability of SCVC to participate in the project. Interest levels may be greater if the proposer can bring some level of cooperation to the project, especially on the project planning and monitoring elements, which are the least likely to have reimbursable funding opportunities.

Potential project sites will then undergo some assessment of the natural resources and mosquito control issues associated with the marsh, as determined cooperatively between the Wetlands Subcommittee and SCVC. This process will allow SCVC to begin to create a conceptual design for the project, and, if possible, move the project towards Screening Committee approval. Once approved (and permitted), the projects will be added to the three year Potential Project list.

2.2 Pre-Application Meetings

Another early action is for the project sponsor to approach potential permitting and otherwise involved or interested agencies. This is distinct from the cooperative development of the Strategy Plan, because this is a site-specific consultation among the project designer, project sponsor, and potential regulators. Some of the likely contacts, other than SCVC, include:

- Town planning departments
- Town natural resource/marine departments
- Trustees
- Suffolk County Department of Health Services (SCDHS)
- Suffolk County Department of Planning (SCDP)

- Estuary program offices (LISS, PEP, SSER)
- New York State Department of Environmental Conservation (NYSDEC) Region I Office of Permits
- NYSDEC Region I Tidal Wetlands Program
- NYSDEC Marine Resources Bureau
- New York State Department of State (NYSDOS) Division of Coastal Resources
- US Army Corps of Engineers, District 2

From an efficiency standpoint, it may be easiest to have individual meetings with the concerned and involved agencies. However, to minimize conflicts, it may be better to try to coordinate a general meeting. It is probably best to identify potential conflicting resource or permitting concerns early so as to allow the most time to come to some resolution, and to allow the involved agencies to understand the conflicts faced by the project sponsor, which may help to facilitate resolutions. This suggests that one, larger meeting, as difficult as it may be to coordinate, may serve project needs best.

The agencies can serve as more than permitting guidance providers, however. They often have invaluable information regarding the sites under consideration. Especially with local agencies, it may be that early contacts result in information exchanges that lead to project modifications, and the construction of more suitable approaches to achieve the project goals.

2.3 Long-Term Plan Wetlands Subcommittee

The Technical Advisory Committee (TAC) created a Wetlands Subcommittee to work with the Long-Term Plan consultants to fashion acceptable approaches to marsh management. The Wetlands Subcommittee was considered to be functionally independent from the TAC, in order that the TAC did not eventually review its own work.

At this time, the Wetlands Subcommittee will have two major responsibilities, relating to project design review, and to generate the Annual Strategy Plan with SCVC each spring, along with several other areas of interest and involvement.

The Wetlands Subcommittee is composed of local experts and natural resource agencies. Therefore, its review of the conceptual plan is important to ensure that the project is consonant with the Goals and Objectives of the Wetlands Management Plan. Involvement by the Subcommittee at an early stage will also likely assist in ensuring that important permit needs are met, and that the project will be favorably received by the Screening Committee. Committee members should endeavor to stay current with the progress of Wetlands Management Plan projects, to ensure that innovations and lessons learned from field experience are incorporated into the Committee's decision making.

Each year the Committee will work with SCVC to fashion an Annual Strategy Plan. This Strategy Plan is intended to serve as guidance for SCVC in attaining the Goals and Objectives of the overall Wetlands Management Plan. As such, it will include elements of policy review, and also specific suggestions and plans for project implementation and further project identification. It will also include a discussion of the kinds and scope of "routine" activities undertaken by SCVC outside of this more formal review process. This is intended to ensure that SCVC remains focused and attentive to the adopted Goals and Objectives, and to ensure that the members of the Subcommittee remain supportive of the water management work conducted by the County.

As mentioned above, each Annual Strategy Plan will address three areas in some detail. One is the identification of new marshes to be considered for action. Candidates may be drawn from the SCVC priority list (see Section 7), nominated by a landowner, otherwise identified by SCVC, or be brought before the Committee by a Committee member. Each marsh should be assessed in terms of potential mosquito control issues, and in order to determine its health and functionality. The status assessment will assist the project designer in identifying the best BMPs for the particular marsh. It will also assist in creating a priorities list for marsh restoration and action. Those marshes with impaired functionalities or with the potential to receive the greatest improvements in overall health are most likely to be identified as the highest priority for

immediate action. An essential element of this section of the report will be discussion of appropriate assessment means to ensure that key marsh attributes and parameters are adequately measured to support these kinds of decisions. This is especially true for those elements of the Wetlands Management Plan Goals and Objectives, such those relating to biodiversity, where current science and monitoring protocols may not be adequate to meet County needs.

The second detailed section of the report will be a discussion of the minor, routine work undertaken by SCVC over the previous year. The report will identify locations, areas affected, and the means chosen for management. This level of scrutiny on an annual basis will allow for review of SCVC actions, and help ensure that even smaller, less widely reviewed projects are conducted in accordance with the Goals and Objectives of the Plan. This discussion will also lead to the formulation of a minor project plan and strategy for the coming year (insofar as the minor projects can be identified on a non-emergency, or other non-pressing time scale). By their very nature, small problems occur without warning, and can be most appropriately addressed usually through immediate action.

The third detailed part of the report will be the identification, and slotting on a prioritized list, of the marsh-wide projects SCVC intends to address over a three year planning window. The need for marsh-wide projects means that it is almost always possible to forecast them some time ahead of any proposed action. Even if the marsh-wide projects do not meet potential impact or acreage triggers, clear identification of these projects in some kind of a strategy document will ensure that they meet important criteria, such as conformance with the Wetlands Management Plan Goals and Objectives, and so it is appropriate to include the smaller projects in the overall Annual Strategy Plan. This allows for rational scheduling, and gives the Committee a stake in resource allocation decisions – which are very important in any prioritization.

The Wetlands Subcommittee should be sensitive to suggest adjusting the Goals and Objectives of the Wetlands Management Plan (the criteria by which the Screening Committee reviews conceptual project plans) as the adequacy of these guides becomes apparent with time. It may be that well-planned, necessary projects are not being approved, although the projects seem to be worthy in terms of overall County needs. It may be that projects are being approved despite a lack of congruence with certain principles that need to be addressed. It is anticipated that a

diverse committee membership will bring the fruits of research, monitoring, and restoration activities outside of County efforts to the Wetlands Management Plan, and incorporate those lessons learned into the Suffolk County approach through on-going revisions to the Goals and Objectives. The Wetlands Subcommittee is also envisioned as an appropriate means to coordinating and incorporating information and resources developed by and through the three main estuary programs that should be of significant assistance. In addition, as greater sophistication regarding the concept of marsh health and functionalities is developed, the Committee should further adjust the Goals and Objectives to reflect those changes. Therefore, the Wetlands Subcommittee needs to be prepared to provide overall policy guidance to the decision-makers by suggesting changes in the Goals and Objectives, by means of the Annual Strategy Plan, to the Screening Committee. The Screening Committee would deliberate on such changes, and coordinate policy revisions through the Steering Committee.

The Wetlands Subcommittee will also be expected to provide input to the Screening Committee regarding the wetlands management portion of the Triennial report on the entire Long-Term Plan (see the Screening Committee, below, for the content of that report).

Membership of the Wetlands Subcommittee will include the local municipalities in the County with an interest and stake in wetlands management. It may also draw some of its members from the following organizations:

- US Army Corps of Engineers
- US Environmental Protection Agency
- US Fish and Wildlife Service (local and regional)
- National Oceanographic and Atmospheric Administration
- Fire Island National Seashore
- LISS
- PEP

- NYSDEC (Region I, Marine Resources, Albany)
- NYSDOS
- New York Sea Grant
- Cornell Co-operative Extension
- SSER
- Long Island Regional Planning Board
- SCDHS
- SCVC
- SCDP
- Suffolk County Department of Parks and Recreation
- Long Island Wetlands Restoration Initiative
- The Nature Conservancy
- Ducks Unlimited
- The Group for the South Fork
- Peconic Land Trust
- Citizens Campaign for the Environment
- Long Island Pine Barrens Society
- Peconic BayKeeper
- Stony Brook University

- Dowling College
- Long Island University
- Hofstra University
- Adelphi University
- Brookhaven National Laboratory

If they can be persuaded to attend, experts from other states' natural resources and/or mosquito control agencies should be considered, especially given the longer history of many states in completing more progressive water management projects. Interested parties can self-nominate to the committee, although actual membership will require approval by the Steering Committee, since the committee formally is a subcommittee of the TAC. The Committee may very well find reasons to create various subcommittees of this Subcommittee to address issues that are geographically limited, for example, or to concentrate expertise on particular sub-topics that may not be of general interest.

The initial membership will consist of the members of the current Wetlands Subcommittee.

2.4 Suffolk County Wetlands Management Screening Committee

A major project will have a conceptual design created by cooperation between the landowner, SCVC, and local and other permitting agencies, and through technical review by the Wetlands Subcommittee. At this point, a presentation can be made to the Screening Committee.

The Suffolk County Wetlands Management Screening Committee is modeled after the Suffolk County Dredge Project Screening Committee. The Dredge Project Screening is composed of County officials who are well-versed in County needs, appropriate regulations, and County self-imposed project criteria. This expertise allows the Committee to rank projects in terms of suitability and accord with County dredging criteria.

The membership of the Wetlands Management Screening Committee is intended to be familiar with goals and objectives of the Wetlands Management Plan. It will have eight members,

appointed from four different sources. The County Executive will appoint three members, who will nominally be the Commissioners of the three County departments with the most responsibilities for vector control and wetlands management – Planning, Public Works, and Health Services. The Governor, who is the regulator of New York State wetlands, will appoint the two officers most responsible for Suffolk County's wetlands management from the State perspective: the Director of NYSDEC Region I, and the Director of NYSDOS Division of Coastal Resources. The County Legislature, through its Presiding Officer, will appoint a representative, and also someone to represent citizen and/or activist concerns. The Town where the wetland is (predominantly) located will also have representation for the decision on that site.

The Screening Committee has three functions. Its primary purpose is to confirm that the project is something that is appropriate for SCVC to undertake. To determine this, the Committee will consider the Goals and Objectives of the Wetlands Management Plan, as described above and amended by the Committee.

The second purpose of the Screening Committee is to provide input regarding the proposal's suitability in terms of other factors, especially those espoused by the organizations serving on the Committee. This will allow the constituent members of the Committee to have input into proposed projects, to help ensure that work undertaken in Suffolk County's wetlands is consonant with the objectives of the major natural resource agencies that are concerned with the County's coastline.

Therefore, the Screening Committee may recommend alterations to the conceptual plan for the project. These changes may be needed to meet the Wetlands Management Plan Goals and Objectives, or to mold the project to more in line with guidelines of other interests.

The scope of the plan presented to the Screening Committee will depend on the scope of the proposed project. Generally, however, natural resource inventories and conceptual plans will need to be complete enough to allow the Committee to envision the general approach of the project. It is likely that the determination of proper scope will be something of an iterative process, based on the perceptions of the adequacy of earlier proposals and the correspondence between the conceptual plan and the actual constructed modification.

In order to ensure that a project has broad-based support, it must receive five affirmative votes in formal consideration by the Committee. The Committee will establish other rules and procedures to ensure its proper functioning, but this basic guideline will help create consensus regarding actions to be taken in County wetlands. This is important, because physical alterations of wetlands can be difficult to undo, and the consequences of the actions, while intended to be beneficial to the natural system, are sometimes difficult to forecast exactly because of the complexity of the processes that affect marshes.

Note that gaining acceptance by the Screening Committee does not ensure that permits will be easily garnered. This is true although the membership of the Committee includes agency representation from key permit issuers, such as NYSDEC, and, through NYSDOS, the US Army Corps of Engineers. Towns and/or trustees may also be permitting authorities. Membership by these organizations on the Screening Committee is intended to bring the natural resource expertise and public policy positions of the permitters to bear. The technical assessment of the project, especially as regards regulations on and rules of use for wetlands, are another matter entirely – or nearly so. It is true that garnering policy approval of the project does suggest an inclination towards permit approval by the agencies.

The final purpose of the Screening Committee is to receive and review wetlands management reports that will be generated by SCVC. These reports will come in two formats. One is an Annual Strategy Plan, which will be cooperatively developed by SCVC and the Wetlands Subcommittee. This was discussed in Section 2.3, above. This, it is anticipated, will be completed by the end of June of each year.

In addition, every three years SCVC will complete a major Evaluation Report regarding progress on the Long-Term Plan. This Triennial Report will necessarily contain a section regarding water management, which will discuss:

- Status reports on initiated and previous major projects, including reviews of compliance with pre-project goals and objectives
- Proposed mitigations for completed projects failing to meet goals and/or objectives, and the responsible party to conduct the mitigation activities

- A discussion of the kinds and scope of all minor water management projects
- A tally of the total acreage addressed during the three year period, and an accounting of the total acreage addressed thus far under the Long-Term Plan
- Progress towards meeting stated Wetlands Management Goals and Objectives, as listed here and potentially altered by the Steering Committee
- Reasons for not attaining the Goals and Objectives, if that is the case
- Proposed remediations to address any shortcomings
- Identified activities for the next three year period

The Screening Committee can submit comments on the report to the Steering Committee for consideration. The Steering Committee will have the responsibility for approving the Triennial Reports.

2.5 Project Design

When a proposed project has passed muster with the Screening Committee, it should move towards final technical design. Any project that seeks to have SCVC involvement in construction should have SCVC involvement in the design phase. It is perhaps more accurate to say all such projects should have SCVC involvement, but there are always rare exceptions to every rule. It should be understood that that it is unlikely that any County wetland group can match the practical experience of SCVC in marsh management and manipulation at this time; following the initiation of the Wetlands Management Plan, it is expected that SCVC expertise will be augmented by even more practical experience.

SCVC has the capabilities to design major projects of all kinds. The Long-Term Plan expects to augment the technical staffing at SCVC to enable it to undertake more and potentially more complex projects than has been the case hitherto. It is likely, however, that the Wertheim National Wildlife Refuge Open Marsh Water Management (OMWM) project represents the most complex project likely to be considered here in Suffolk County, although some technical aspects

of that project and its design may be addressed in a more sophisticated fashion in some future work.

The design process is meant to be collaborative. SCVC will have certain preferences to meets its agency goals. However, SCVC has also expressed the view that many natural resource needs can be addressed while allowing mosquito control needs to be satisfactorily addressed at the same time. SCVC's experience will allow it to practically determine the scope of the project, and enable issues such as timelines, construction resource needs, and funding to be better estimated by the project sponsor.

The design process will involve drawing from the BMP Manual, in light of project sponsor needs and goals. The BMP Manual is not intended to be restrictive, but rather to serve as a collection of methods that have been shown to achieve certain ends. They can be modified or adapted, as individual sites need, or project goals require. In fact, it is best if it is understood that each marsh has individual characteristics that probably require modifications to past marsh modification implementations, to ensure that the project plans are optimal, and that the proposed modifications have the greatest chance of success. Cookie cutter approaches may lead to many failures, due to site specific conditions that do not mesh with archetypes.

2.6 Permitting

No project shall be considered by SCVC for implementation absent necessary permits. It should be understood that in some instances, projects on federal lands or sponsored by federal agencies may be exempt from the need to acquire state and local permits. Similarly, projects on State lands or sponsored by State agencies may be exempt from local permitting requirements, and projects on County lands or sponsored by County agencies may be exempt regarding other local permits. Nonetheless, it is expected that all agencies will respect the regulatory authority that could potentially be raised by any level of government; whether a permit is actually secured or not, collaboration and cooperation are expected to be the means by which the design of the project is reached. Respect for the expertise and concerns of regulators can allow projects to be developed that otherwise might founder due to agency hostility. All of those with concerns about the County's wetlands can enhance this proposed process, and therefore lead to improvements in the health and other natural aspects of the County's wetlands.

It is the responsibility of the landowner to secure the necessary permits. In a practical sense, the project sponsor will be responsible for acquiring all needed permissions. Overarching County interest in a particular project may result in County assistance in the permitting process. It is key that responsibility for permitting be determined early in the project development.

Because of the current state of inactive interest in salt marsh projects by the US Army Corps of Engineers, it is strongly recommended that SCVC meet with the Corps on an annual basis. At this meeting, the Corps can be informed of proposed new projects, and the status of past projects. This will allow for smoother implementation of whatever permitting process the Corps deems necessary for particular classes of actions.

2.7 Implementation

Involvement in this process assumes that SCVC will assist in construction, and probably will be the main construction agency. With that understood, it is still necessary that the project sponsor maintain an active role in construction oversight to ensure that project goals and objectives are followed, and that the project design is adhered to.

2.8 Monitoring

The development of appropriate project monitoring protocols is necessary for every project. NYSDEC has correctly identified a major fault in almost all water management projects undertaken by a variety of organizations in Suffolk County over the past 20 years. That is the lack of monitoring of the impacts of the project. This continuing failure must be addressed. It is through good monitoring of projects, for example, that the Wetlands Subcommittee shall collect the information to help meet its responsibilities.

All reversion projects, for example, will be carefully monitored. Through remote rearing, the overall area of vegetated marsh and gross measures of individual communities (how marsh, high marsh, mixed vegetated areas, and *Phragmites* areas) will be quantified. Trends will be developed, and if indicating are that the wetland degrading. A site investigation will be undertaken to determine if reversion has been a factor on the impacts.

Not all projects require the same degree of monitoring. For example, the hard costs associated with the monitoring program at the Wertheim demonstration project have exceeded $100,000 per year, with substantial soft costs not included in that rate. This level of effort is inappropriate for much smaller, less significant projects – and may not be required even for a project of the scope of that major wetland restoration. Nonetheless, it is clear that all projects require pre-project inventories and post-project follow-up. It may be that photo documentation is sufficient for some – but certainly not for all.

The level of monitoring needs to be sufficient to determine if the project is meeting its stated goals and objectives. For smaller projects, it is possible that existing SCVC and/or Town environmental assessments will be sufficient, perhaps with some augmentation or redirection, to provide adequate information to meet this criterion. For larger projects, it is likely that some project-specific monitoring effort will need to be mounted. Some of these issues can be resolved through the Wetlands Subcommittee-SCVC determinations of the best means of conducting marsh assessments (to be developed as part of the Annual Strategy Plan).

In practical terms, it is likely that agencies such as Town natural resource departments, the SCDHS Office of Ecology, and/or Cornell Co-operative extension are best equipped, and have the moist appropriate kinds of experience, to conduct the kind of monitoring that is likely to be required. Various environmental consulting companies and some of the NGOs also have the required expertise.

It has also been noted that ambitious, continuing monitoring efforts, such as the Colonial Waterbird Survey, can sometimes be successfully implemented using volunteers. Most permit-oriented monitoring projects avoid using volunteers because of the responsibilities associated with permit conditions; however, this may be a means to reduce costs and expand the scope monitoring programs for select projects.

3 ACTION HIERARCHY

The BMP manual (see the Appendix) outlines how the needs of SCVC will be met through wetlands management and restoration projects. As stated above, the manual is intended to be a flexible guide, not a cookbook. Specific implementations at any site will be dependent on site-specific factors, and landowner/project sponsor requirements and desires.

The BMP Manual is organized hierarchically, presenting those actions that are likely to cause the least change to the existing wetland first, and those that are likely to have greater impacts secondly. This structure was adopted so that decisions could be made in a setting where it is understood that it is preferable to try to meet project needs while impacting the existing environment least.

Nonetheless, it is not certain that it is preferable to select projects on the basis of causing the least disturbance to the existing environment. Where the existing marsh has been judged to be degraded, it is likely that a project goal will be to enhance the existing environment so as to upgrade marsh functionalities. Therefore, it is entirely possible that projects will be selected because they promise to result in changes to the existing marsh.

The following is a summary presentation of the BMP Manual. The BMPs have been divided into four kinds of action:

- those with no or minimal impacts

The presumptive interim action for County Wetlands is reversion. Non-intervention in natural systems can recap environmental benefits, although extensive monitoring of these sites will be conducted to ensure impacts do not occur before long-term restoration management plan is adopted.

- those with minor impacts

Note that selective ditch maintenance has been included in the BMPs in this section. Nearly all of Suffolk County's marshes were ditched at one time or another. These ditches may very often have value as a source control measure for mosquito management. Where the general marsh

setting has been judged to provide the kinds of functions that it is expected to, and there is a localized, excessive mosquito breeding problem that may impact human health, in conjunction with hydrological failure of the existing ditches, it is possible that selective, limited maintenance of the ditches will be the kind of action that should be pursued. Needs for additional natural resource enhancements may result in selecting against ditch maintenance. No ditch maintenance will occur without review of the project by SCDHS Office of Ecology. In addition, the concerns and issues of local agencies will be cooperatively and appropriately addressed. In any event, the County projects that the maximum area of salt marshes affected by ditch maintenance each year will be on the order of 50 acres – including acreage addressed under Interim Management/Ongoing Maintenance Actions. Given that the County has an inventory of approximately 17,000 acres of salt marsh, it is clear that the Long-Term Plan does not envision ditch maintenance being the major marsh management tool for SCVC. In no case does the Wetlands Management Plan call for the construction of new grid ditches.

- those with major impacts
- interim actions

As mentioned above, the presumption interim action is for reversion of the marsh, through a policy of non-intervention management. Interim actions are only selected because a preferred alternative cannot be implemented. At curtain sites when some degree of water management is needed, and, in some cases, where the need is carefully documented, ditch management may be undertaken.. As discussed above, the sum of BMP and IMA ditch maintenance is expected to sum to less than 50 acres in any particular year of the Long-Term Plan.

The following four tables provide some details regarding these four groups. The BMP Manual itself, included in this report as an Appendix, provides much more detail and explanation regarding these choices.

Table 1. Management Activities for Minimal or No Action

BMP	Action	Factors to Consider	Benefits	Impacts	Equipment to be used	General Compatibility With Tidal Wetlands 6 NYCRR Part 661*
BMP 1.	Natural processes (reversion/no action)	- Land owner prefers natural processes to proceed unimpeded - Natural reversion is actively infilling ditches - No existing mosquito problem	- Return to pre-ditch hydrology - More natural appearance/processes - Requires no physical alterations	- Possible increase in mosquito breeding habitat, creation of problem - Loss of ditch natural resource values - Loss of tidal circulation - Phragmites invasion if fresh water is retained on marsh - Drowning of vegetation if excess water is held on marsh	Not applicable	NPN
BMP 2.	Maintain/repair existing culverts	- Flooding issues - Are existing culverts adequate for purpose? - Are existing culverts functioning properly?	- Maintain existing fish and wildlife habitats - Maintain tidal flow and/or prevent flooding	- Continue runoff conveyance into water bodies - Roads & other associated structures	- Hand tools (minor maintenance) - Heavy equipment for repair	GCp
BMP 3.	Maintain/ reconstruct existing upland/ fresh water* ditches	- Flooding issues - Are existing ditches supporting flood control? - Are existing ditches needed for agricultural uses?	- Maintain existing fish and wildlife habitats and hydrology - Prevent or relieve flooding - Support turtle habitat - Provide fish habitat	- Continue runoff conveyance into water bodies - Perpetuate existing degraded conditions - Excess drainage	- Hand tools (minor maintenance) - Heavy equipment for reconstruction (rare)	NPN (6 NYCRR Part 663)

* Local regulations may or may not be more stringent than these State regulations

Table 2. Management Activities for Minor Impacts

BMP	Action	Factors to Consider	Benefits	Impacts	Equipment to be used	General Compatibility With Tidal Wetlands 6 NYCRR Part 661*
BMP 4.	Selective Maintenance/ Reconstruction of Existing Salt Marsh Ditches	- Local government issues and concerns resolution - SCDHS Office of Ecology review - Mosquito breeding activity - Land owners long-term expectations - Overall marsh functionality - Ditch maintenance is to be selective and minimized	- Enhance fish habitat - Maintain existing vegetation patterns - Maintain existing natural resource values - Allow salt water access to prevent/control Phragmites - Reuse pesticide usage	- Perpetuate ongoing impacts from ditching	- Hand tools (minor maintenance) - Heavy equipment for reconstruction	NPN
BMP 5.	Upgrade or install culverts, weirs, bridges	- Flooding - Flow restrictions - Associated marsh impacts - Cooperation from other involved departments	- Improve tidal exchange and inundation - Improve access by marine species - Increase salinity to favor native vegetation - Improve fish habitat & access	- Negative hydrological impacts - Changes in vegetation regime	- Heavy equipment required	GCp
BMP 6.	Naturalize existing ditches	- Grid ditches - Mosquito breeding activity - Landowner needs - In conjunction with other activities	- Increase habitat diversity - Increase biofiltration - Improve fish habitat and access by breaching berms	- Hydrology modification - Minor loss of vegetation - Possible excess drainage	- Hand tools (minor naturalization) - Heavy equipment for major	NPN/GCp
BMP 7.	Install shallow spur ditches	- Mosquito breeding activities - Standard water management not successful (continued larviciding)	- Increase habitat diversity - Allow higher fish populations - Improve fish access to breeding sites	- Drainage of ponds and pannes - Hydraulic modification - Structure not stable	- Preferably hand tools	NPN/GCp
BMP 8.	Back-blading and/or sidecasting material into depressions	- Mosquito breeding activities - Standard water management not successful (continued larviciding)	- Improve substrate for high marsh vegetation - Compensate for sea level rise or loss of sediment input - Eliminate mosquito breeding sites	- Excessive material could encourage Phragmites or shrubby vegetation - Materials eroded so that application was futile	- Heavy equipment required	NPN or GCp
BMP 9.	Create small (500-1000sq. ft) fish reservoirs in mosquito breeding areas	- Mosquito breeding activities - In conjunction with other water management - Natural resource issues	- Increase wildlife habitat diversity/natural resource values - Improve fish habitat - Eliminate mosquito breeding sites - Generate material for back-blading	- Convert vegetated area to open water with different or lower values	-Heavy equipment required	Status Undetermined

* Local regulations may or may not be more stringent than these State regulations

Table 3. Management Activities for Major Impacts

BMP	Action	Factors to Consider	Benefits	Impacts	Equipment to be used	General Compatibility With Tidal Wetlands 6 NYCRR Part 661*
BMP 10.	Break internal berms	- Water quality (poor) - Standing water (mosquito breeding) - Impacts on structural functions	- Allow access by marine species - Prevent waterlogging of soil and loss of high marsh vegetation - Improve fish access to mosquito breeding sites - Prevent stagnant water	- Changes in system hydrology - Excessive drainage of existing water bodies - Introduction of tidal water into areas not desired	- Hand tools (minor) - Heavy equipment (major)	Pip
BMP 11.	Install tidal channels	- Improve water quality - Tidal ranges and circulation - Increase salinity (invasive vegetation) - Natural resources enhancement	- Improve tidal exchange - Improve access by marine species - Increase salinity to favor native vegetation - Improve tidal inundation - Improve fish habitat	- Changes in system hydrology - Excessive drainage or flooding of uplands - Increase inputs from uplands into water body	- Heavy equipment	P
BMP 12.	Plug existing ditches	- Improve fish habitat - Tidal ranges and circulation - Prevent upland inputs - Natural resources enhancement	- Return to pre-ditch hydrology & vegetation - Reduce pollutant conveyance through marsh - Provide habitat for fish & wildlife using ditches - Retain water in ditch for fish habitat - Deny ovipositioning sites	- Changes in system hydrology - Reduce tidal exchange - Reduce fish diversity in ditches due to lack of access - Impoundment of freshwater could lead to freshening & Phragmites invasion - Possible drowning of marsh vegetation	- Heavy equipment	P
BMP 13.	Construct ponds greater than 1000 sq.ft.	- Landowner's needs - Water fowl habitat - Natural resources enhancement - Aesthetic improvements	- Increase habitat values for targeted species and associated wildlife - Improve habitat for fish - Eliminate mosquito breeding sites	- Changes in system hydrology - Convert vegetated areas to open water with different and possibly lower values	- Heavy equipment	P
BMP 14.	Fill existing ditches	- Landowner's needs - Aesthetic improvements - To restore pre-ditch hydrology - Vegetated areas	- Return to pre-ditch hydrology and vegetation - Reduced likelihood of pollutant conveyance through marsh - Create vegetated habitat to replace that lost by ditches or by other alterations - Deny mosquito breeding habitat by eliminating stagnant ditches	- Potential to create new breeding habitats if ditches are not properly filled or by making the marsh wetter - Loss of ditch habitat for fish, other marine species & wildlife using ditches - Loss of tidal circulation - Phragmites invasion if freshwater is retained on marsh - Drowning of vegetation if excessive water is held on marsh	- Heavy equipment	P
BMP 15.	Remove dredge spoils	- Increase wetland habitat	- Convert low-value upland to more valuable wetland habitats - Eliminate mosquito breeding sites	- Could result in new breeding sites if not carefully designed - Major change in local topography	- Heavy equipment	P

* Local regulations may or may not be more stringent than these State regulations

Table 4. Interim Management/Ongoing Maintenance Actions

Interim Action	Action	Factors to Consider	Benefits	Impacts	Equipment to be used	General Compatibility with Tidal Wetlands 6 NYCRR Part 661*
IMA1.	Natural processes (No action reversion)	-Presumptive interim action	- Non-intervention in natural system	- Non-intervention in natural system	- Non-intervention in natural system	- Non-intervention in natural system
IMA 2.	Selective ditch maintenance (Standard Water Management)	- mosquito breeding activity - water quality (poor) - improve fish habitat	- Enhance fish habitat - Maintain existing vegetation pattern - Improve fish access to breeding sites - Increase fish and wildlife habitat diversity - Increase biofiltration - Improve fish habitat and access by breaching berms	- Perpetuate ongoing impacts from ditches - Hydrology modificatio n - Minor loss of vegetation - Possible excess drainage of marsh surface	- Hand tools (Minor) - Heavy equipment (Major)	NPN
IMA 3.	Culvert repair/maintenance when tidal restrictions are apparent	- improve water quality - restore pre-restriction hydrology -mosquito breeding activities	- Maintain existing habitat - Maintain existing flows and/or prevent flooding	- Continue runoff conveyance into water bodies - Potentially inadequate water transmission	- Heavy equipment	NPN
IMA 4.	Stop-gap ditch plug maintenance	- prevent upland inputs - increase wetland habitat - sustain fish and wildlife habitat	- Return to pre-ditch hydrology & vegetation - Reduce pollutant conveyance through marsh - Provide habitat for fish & wildlife using ditches - Retain water in ditch for fish habitat - Deny ovipositioning sites	- Reduce tidal exchange - Reduce fish diversity in ditches due to lack of access - Impoundment of freshwater could lead to freshening & Phragmites invasion - Possible drowning of marsh vegetation - Impermanent approach (likely to fail within 5 years)	- Heavy equipment	GCp

* Local regulations may or may not be more stringent than these State regulations

4 IMPLEMENTATION

The County wishes to aggressively implement the actions described above. This will have a tendency to accelerate implementation beyond the pace that might be expected for a nascent program. It appears there is a confluence of available funds, through federal, State, and local restoration sources. This should make it possible for the Plan to conduct all necessary planning processes within a decade, and to implement construction within twelve years or so.

Regulators, especially those at NYSDEC, have been very cautious regarding water management projects proposed under other management programs. This stems from several general considerations:

1. Jamaica Bay, which has been manipulated in many ways over the past hundred years or so, has experienced sudden losses of salt marsh. The processes driving this wetland loss are not yet completely determined. It is not clear if the wetlands are disappearing because of actions outside of the marshes that are impacting them, or because of forces acting within the marsh itself (or, some combination of the two). Therefore, it is far from clear that the condition(s) that may be causing the problem is (are) unique to Jamaica Bay. This makes regulators loathe to allow actions that may create some of the conditions found in Jamaica Bay.

2. Many natural resource specialists think many salt marshes in Suffolk County are functioning well, in terms of certain specific ecological services such as providing fish habitat. Alterations to existing conditions could lead to diminishments of this or other functionalities.

3. NYSDEC has a legislative mandate to ensure that there is no loss of salt marsh acreage. Salt marsh acreage is measured in terms of vegetated areas. Therefore, projects proposing to add to surface waters within a marsh are in potential conflict with State law.

4. Local regulators have expressed concerns that some proposed projects have not been well defined or have not had goals and objectives clearly expressed. In a sense, these regulators are concerned that some projects have been proposed merely to be "doing something," or because neighboring jurisdictions are conducting similar projects.

5. Because of a lack of dedicated resources, some past marsh manipulations have not been well-documented, and have not been shown to have met goals and objectives associated with them. Regulators do not want to allow projects to be implemented without assurances that the success (or failure) of the project will be demonstrable.

This Wetlands Management Plan and the general approach undertaken by the County in producing the Wetlands Management Plan are intended to directly address these concerns. The County anticipates that these concerns have been adequately addressed in the Wetlands Management Plan and through the conduct of the Wertheim National Wildlife Refuge OMWM Demonstration Project. The County understands that some of these objections to marsh management may be slow to be completely assuaged, but will do its best to continue to address State concerns on these and other matters.

Similarly, some local governments and non-governmental organizations have been concerned that past practices of SCVC in managing marshes have not been as cooperative as it is possible to be. This Wetlands Management Plan has been created to bring potentially aggrieved parties into decision-making processes, and to make the SCVC wetlands management process much more open, and subject to greater comment and oversight. Suffolk County's wetlands, especially its salt marshes, are recognized by the County as irreplaceable resources. The County has no intention, whether for mosquito management or other reasons, to damage these resources. The County believes that by cooperatively identifying and selecting projects, and by including other interests in the project oversight and design processes, that beneficial management plans for the wetlands can be developed and implemented.

There is one major barrier towards implementation of the BMPs that the County clearly has no control over. That is the NYSDEC ownership of many salt marshes throughout the County,

especially a great many sites identified as containing mosquito breeding problems. NYSDEC has a regulatory requirement to execute a process called "Unit Management Plans" for its holdings, prior to making major management decisions about them. This is intended to be a public process, with formal filings requirements and hearings. It is designed to ensure that the State manages its lands in such a way as to account for the sometimes divergent opinions about the best means for the lands to be used and kept. Under the best conditions, the process requires at least a year to complete, if the resource managers involved in the process can devote extensive time to it.

Unfortunately, NYSDEC Region I resource managers are almost exclusively assigned to permit assessments and similar regulatory needs. In addition, Albany has not made it clear whether each Tidal Wetland area will need to be assessed separately, or if a more generic assessment and plan can be undertaken. Therefore, due to a lack of personnel and policy determinations, no Tidal Wetland has undergone the Unit Management Plan process yet, nor is there any likelihood of the process occurring in the foreseeable future. This gravely limits the scope of the Management Plan, and handicaps its overall goal of reducing pesticides applications.

5. RESOURCE ALLOCATIONS

The BMP manual describes personnel and equipment needs associated with the kinds of projects considered there. The Long-Term Plan discusses possible reconfiguration of SCVC to meet the needs and demands of the Wetlands Management Plan outlined here, as well as other SCVC requirements under the overall Long-Term Plan.

This would require additional personnel to meet responsibilities. The priority position for water management is the principal engineering aide, to permit the quick production of accurate project drawings to address new technical needs. The second priority would be the Director of Natural Resources, to allow for expanded planning for future projects. Another important component of the wetlands management approach is the Assistant Civil Engineer. Other identified positions are important for SCVC to meet all of its assumed responsibilities under the proposed plan.

In the proposed 2006 County budget, the County Executive added two positions to SCVC (an Entomologist and an Engineering Aide), which were described as the highest priority positions needed to begin implementing the Long-Term Plan. The Engineering Aide had been described as the top priority for initiating the Wetlands Management Plan. These positions are proposed to be funded from Quarter-cent revenues.

Positions identified by SCVC to meet needs for the Long-Term Plan appear to require approximately $600,000 in salary commitments (at entry level salaries), if all were to be filled. Approximately half of that salary commitment would appear to meet the requirements associated with Quarter-cent funding (if available). Staff associated with the on-going construction-restoration activities in wetlands may also be eligible for cost sharing under various environmental restoration funds at many levels of government.

The Management Plan, as currently constituted, will require the purchase of a 16-inch rotary-arm ditcher attachment ($25,000), a long-reach excavator ($125,000 - $150,000), a four-foot wide grading bucket for the excavator ($10,000), and two personnel transporters (at $15,000 each). The justifications for these purchases are given in the BMP Manual. This $200,000 capital purchase may be recoverable through marsh restoration grant opportunities.

6. TIMELINE

The County intends to assess, through the Wetlands Management Plan process outlined here, all of its salt marshes within the next 10 years (by 2015). This is achievable because the County contains approximately 17,000 acres of salt marsh. Through the Long-Term Plan planning project, over 2,100 acres have been assessed. In addition, approximately 4,000 acres of the County's salt marshes are unlikely to need any kind of remediation action (in the No Action category of the BMP manual). This can be confirmed relatively quickly. Thus, approximately 11,000 acres of wetlands require more detailed assessment. This would require approximately 1,000 acres to be assessed each year to meet the goal.

The County has also committed to implementing its plans within 12 years (allowing two additional years, maximum, to implement the assessments). This is exceedingly ambitious, given uncertainties associated with restoration activities in State Tidal Wetlands (noted above in Section 4). If these uncertainties can be resolved, and willing landowners abound, then the County anticipates conducting a major salt marsh restoration approximately every two years in the first six years of the plan, and one a year for the next six years (allowing a cycle of one year for site assessment and project planning, and a year for implementation), meaning that it should be able to conduct approximately nine of these major projects over next 12 years. In addition, at the end of the 12 year implementation cycle, all Interim Management/Ongoing Maintenance Actions would have been replaced by more permanent BMPs.

The County envisions moving forward with its minor project needs immediately, and completing all of the required work over the 12 year period. The first year's work will also require the development of practical permitting and approval processes with NYSDEC and the Towns in order that these projects can be accomplished within appropriate time frames.

The intent of all these marsh management activities is to drastically reduce the use of chemicals for mosquito control. The County envisages that the acreage of larvicide applications will be reduced by on the order of a third within five years, and approximately 75 percent by the end of the 12 year implementation period. Meeting there goals assumes that NYSDEC has permitted the kind of projects outlined by the BMPS, so that progressive

water management has been implemented across the 4,000 acres of marches that currently receive aerial larviciding.

7. PRIORITIZED WETLANDS

Suffolk County has approximately 17,000 vegetated acres of tidal wetlands. Approximately 4,000 acres of salt marsh is larvicided on a consistent basis using aerial applications. These sites represent major, persistent mosquito breeding problems. They clearly are the priority sites for SCVC to address, in order to significantly decrease its use of larvicides. Table 5 lists these marshes (by Town).

Table 5. Aerially-Larvicided Salt Marshes

Town	Marsh
Babylon	Captree Island East of Robert Moses Causeway Captree Island West Cedar Beach Gilgo Gilgo Island Helicopter Island Oak Beach/Sore Thumb Oak Island West Gilgo
Brookhaven	Beaverdam Creek Fireplace Neck/Manor of St. George Hedges (Abbotts) Creek Johns Neck Creek Lyman Marsh Mastic Beach Pattersquash Island Sayville Yacht Club Smith Point North Stillman Creek Wertheim NWR
East Hampton	Accabonac Harbor Napeague Harbor
Huntington	None
Islip	Captree Island East of Robert Moses Causeway Clam Pond Heckscher State Park/Quintuck Creek/Scully & Webster Estates/Scully Audubon/Islip Preserve Gardiner Estate/Gardiner Park Ludlows Creek/Benton Bay Namkee Creek Nature Conservancy Isbrandsen State TW/ Admiralty Island Quintuck Creek Pepperidge Hall State TW Pickman Remmer State TW/Idle Hour Seatuck NWR Timber Point State TW West Sayville/Indian Creek/ West Oak Recreation
Riverhead	Baiting Hollow Indian Island
Shelter Island	None
Smithtown	Sunken Meadow
Southampton	Iron Point Moneybogue Bay North Haven/Short Beach North Sea Harbor Shinnecock Bay, South Side/Meadow Lane/Westhampton Dunes Stokes-Poges/Jagger Lane
Southold	East of Pipes Cove/Pipes Neck Creek West of Pipes Cove/Kerwin Boulevard

Similarly, it seems fairly certain that certain marshes in the County do not and will not, as can be foreseen, constitute a mosquito problem. This is not to say that these marshes do not breed mosquitoes. However, some of the sites are off-limits for marsh management, and others do not have enough people in close enough proximity to create a mosquito problem, per se. And some of these marshes do not seem to breed large numbers of mosquitoes under any conditions. Because of this, these marshes will not be considered by SCVC for marsh management. The marshes are listed in Table 6.

Table 6. Non-Intervention Marshes (Marshes with no SCVC Mosquito Problems)

Town	**Marsh**
Babylon	Captree Island East Captree Island West Cedar and surrounding islands Eldar, Great and Helicopter Island & Bay Islands Seganus Thatch, Oak Island West Cedar Island Complex
Brookhaven	East Fire Island Flax Pond Great Gun Marsh Mt. Sinai Harbor Otis Pike Wilderness Area Ridge Island Stony Brook Harbor Wading River West Watch Hill
East Hampton	Gardiners Island Northwest Creek
Huntington	Crab Meadow Lloyd Neck, Caumsett State Park
Islip	Captree Island East of Robert Moses Causeway
Riverhead	Wading River
Shelter Island	Mashomack Forest Preserve
Smithtown	Nissequogue River Stony Brook Harbor
Southampton	Cowyard Beach to Goose Creek Hubbard Creek Jessup Neck Robins Island Sebonac Creek
Southold	None

The marshes in Table 6 may be considered for restoration for other, non-vector control reasons. For example, Crab Meadow is listed as one of the marshes that SCVC has no marsh management interest in. It has been identified by the LISS for marsh restoration. The reason it was so identified is probably the presence of the mosquito ditches there. However, those ditches may

also be the reason that the marsh does not breed mosquitoes in any large numbers. Therefore, if Crab Meadow is selected for marsh restoration by some organization, SCVC would probably have an interest in the project. Prophylactic water management measures that meet the other needs of the restoration may ensure that the marsh continues to not support mosquitoes. Therefore, presence on the Table 6 list does not signal an absolute disinterest in a particular marsh for SCVC.

However, the two lists also describe a third list. These are the marshes that do not have a current determination regarding a need for mosquito management (Table 7). These are the marshes that clearly need research to determine if a mosquito problem requires addressing, and, if so, the optimal means of mitigating the problem while meeting all of the Goals and Objectives that have been set forth here.

Table 7. Marshes Needing Assessment

Town	**Marsh**
Babylon	None
Brookhaven	Bellport Bay State Tidal Wetlands Conscience Bay Cupsogue County Park/Swan Island Dunton Creek Forge River Harts Cove Havens Point Heils Creek Moriches Inlet Mud Creek Port Jefferson Harbor Radio Point Setauket Harbor Smiths Point Park Swan River Terrell River Tuthill Cove West Meadow Creek, Stony Brook William Floyd Estate
East Hampton	Alewife Pond and Cedar Point Fresh Pond Georgica Pond Lake Montauk Little Northwest Creek Montauk Point Oyster Pond Three Mile Harbor
Huntington	Asharoken, Southeastern End Duck Island Harbor North Cove Duck Island Northeast Side Duck Island West Side Eatons Neck, Winkle Point Huntington Harbor, West End Lloyd Neck, East Beach Lloyd Neck, South Shore Lloyd Neck, West End Morgan Estates Northport Harbor, Island and Yacht Club St. Johns Marsh, Cold Spring Harbor
Islip	Browns River State Tidal Wetlands Sexton Island
Riverhead	Browns Point Iron Pier Area Reeves and East Creeks South Jamesport Terry Creek-Meetinghouse Creek

Town	Marsh
Shelter Island	Cattail Pond Coecles Inlet Crab Creek Dering Harbor Smith Cove, South Ferry Town Beach West Neck Harbor
Smithtown	None
Southampton	Cold Spring Pond Cowyard Beach to Goose Creek Cupsogue County Park/Swan Island North Haven, South and East Sides Mecox Bay Peconic River Penniman Cove Penniman Creek Pine Neck Quantuck Bay Red Creek Pond Reeves Bay Sagaponack Lake Speonk River Squire Pond Stock Farm Taylor and Heady Creeks & Shinnecock Indian Reservation Westhampton Beach Wooley Pond
Southold	Brush Creek Cedar Beach Corey Creek Cutchogue Harbor, East Creek, Mud Creek, Haywater Cove, Broadwater Cove Cutchogue Harbor, Wickham Creek Dam Pond and Orient Causeway Deephole Creek Downs and West Creeks Goldsmith Inlet Park Goose Creek Gull Point and Sterling Creek Hashomomuck Pond Hippodrome Creek James Creek Jockey Creek, Town Creek Little Creek Long Beach Bay Mattituck Inlet and Creek Meadownw Beach Preserve Nassau Point Orient State Park Paradise Point Reydon Shores Richmond Creek

The attached map (separate file, if an electronic version) shows the three sets of marshes (Map 1, Suffolk County Marsh Management Plan).

APPENDIX

Best Management Practices Manual

Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

Task 10: Management Plan
Salt Marsh Management
Best Management Practices Manual

Submitted to:

Suffolk County Department of Public Works
Suffolk County Department of Health Services
Suffolk County, New York

Submitted by:

CASHIN ASSOCIATES, P.C.
1200 Veterans Memorial Highway, Hauppauge, NY

June 2005

SUFFOLK COUNTY VECTOR CONTROL AND WETLANDS MANAGEMENT LONG - TERM PLAN AND ENVIRONMENTAL IMPACT STATEMENT

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TABLE OF CONTENTS

TABLES

EXECUTIVE SUMMARY

Suffolk County Vector Control (SCVC) has the task of controlling mosquitoes so as to minimize impacts to human health and public welfare. One means that is recognized as being effective for mosquito control is to address larval populations through water management. Water management can be conducted so as to minimize habitat for mosquito breeding and/or to maximize habitat values for predation on mosquito larvae.

Water management in wetlands implies affecting the hydrology of the wetlands. This could have environmental consequences for the marshes. Some traditional means of conducting water management in Suffolk County's wetlands (specifically, constructing ditches and then maintaining the ditch system) are thought to have had negative environmental impacts, although it is clear not all ditched marshes were similarly affected. In other jurisdictions, more progressive means of water management have been adopted. These progressive methodologies, which are sometimes grouped under the broad title of Open Marsh Water Management (OMWM), are intended to be effective means of mosquito control, and to also enhance other natural resource values where they are applied.

New York State regulations make almost all water management actions in fresh water environments impermissible. The focus of water management in Suffolk County will be on salt marshes, therefore. Salt marshes, which superficially resemble one another, tend to be different in aspects that are very important, especially aspects related to whether or not a proposed water management technique will minimize environmental impacts and maximize environmental benefits. Therefore, most salt marsh systems need to be carefully considered prior to selecting a management technique to address mosquito breeding.

SCVC, as the County agency most involved in water management, has also become the responsible party for a variety of other water management structures, and for the maintenance and replacement of such structures, such as culverts, dikes and weirs. The maintenance and replacement of such structures can also affect mosquito breeding, and also the ecological conditions in the areas affected by the water flows associated with the

structures. Therefore, work associated with culvert, dikes and weir maintenance and repair similarly should be carefully analyzed before it is conducted.

This Best Management Practice (BMP) Manual is intended to identify preferred means to conduct work in Suffolk County wetlands. The conditions that are suitable for the implementation of each BMP are identified as well as the benefits and impacts that could occur following the work. The kinds of equipment needed for the work, the regulatory status of the action, funding sources, and personnel requirements are all spelled out, to enable SCVC to establish its marsh management program properly, and then to make appropriate decisions regarding each mosquito breeding area it evaluates.

The BMPs are collected in four categories. Three categories relate to permanent actions to address mosquito issues. There are three BMPs that are described as having little to no impacts on the existing marsh conditions, six that are described as having minimal impacts to the existing conditions, and six that have the potential to have major impacts on the existing condition of the marsh. The BMPs are thus organized in a loose hierarchy.

However, it must be understood that in many cases the existing condition of the marsh may not be acceptable. The major changes are often exactly the appropriate kinds of actions to be taken where the marsh is degraded in some fashion. The hierarchy of BMPs, therefore, is not simply to be followed, or used as a process diagram that cannot be deviated from. Rather, it is a list of actions which, if applied under appropriate conditions to address specific problems, should have positive outcomes.

The BMPs are as follows:

No to Minimal Impacts:

- BMP 1. Natural Processes (no action/reversion)

  Reversion is to be the presumptive interim action for County wetlands, pending identification of a preferred active restoration plan for each wetland.

- BMP 2. Maintain/repair existing culverts, weirs, bridges
- BMP 3. Maintain/reconstruct existing upland/fresh water ditches

Minor Impacts:

- BMP 4. Selective maintenance/reconstruction of existing salt marsh ditches

Maintenance of ditches will only occur under well-defined conditions, subject to local concerns and input.

- BMP 5. Upgrade or install culverts, weirs, bridges
- BMP 6. Naturalize existing ditches
- BMP 7. Install shallow spur ditches
- BMP 8. Back-blading and/or sidecasting material into depressions
- BMP 9. Create small fish reservoirs in mosquito breeding areas

Major Impacts:

- BMP 10. Break internal berms
- BMP 11. Install tidal channels
- BMP 12. Plug existing ditches
- BMP 13. Construct larger ponds
- BMP 14. Fill existing ditches
- BMP 15. Remove dredges spoils

Selective maintenance of existing mosquito ditches is identified as a BMP. This is because the existing ditches have been shown to control mosquitoes in some situations,

partly by draining standing water from the marsh (especially where tidal ranges are greater) but also by fostering habitat for insect-consuming fish near mosquito breeding areas. The Wetlands Management Plan intends to utilize this technique for marshes where the existing conditions are providing adequate marsh functionalities, and where mosquito breeding is localized in an area where the ditches are clogged and not transmitting water well. If these conditions create a public health risk by fostering excessive mosquito breeding, or reducing the mosquito breeding can reduce pesticide applications, then maintenance of the existing ditches can be considered. Ditch maintenance will only be considered when other natural resource enhancements are not being prioritized. The perception of planners is that these areas will encompass, at most, some 50 acres of marsh a year of the existing 17,000 acres of salt marsh in the County. Sites will only be addressed by ditch maintenance when local concerns and issues have been cooperatively addressed, and after consulting with SCDHS Office of Ecology. It must be emphasized that ditch maintenance will not be the primary means of conducting water management under the Long-Term Plan.

In some instances, it will not be possible to immediately implement preferred long-term management programs at particular sites. In those cases, Interim Management Practices can be sued until more permanent approaches are undertaken. The four Interim Management/Ongoing Maintenance Actions are:

- IMA 1. Natural Process (No action reversion)
- IMA 2. Selective ditch maintenance
- IMA 3. Culvert repair/maintenance when tidal restrictions are apparent
- IMA 4. Stop-gap ditch plug maintenance

Reversion is the presumptive interim action. All marshes undergoing reversion will be monitored to ensure that no catastrophic changes in vegetation patterns result from having no active management. The ditch maintenance activities identified here will also

be limited in scope at any particular site. It is intended that the sum of interim and BMP ditch maintenance be less than the 50 acres a year target identified above.

1 INTRODUCTION

As an element of the Suffolk County Wetlands Management Plan, this Salt Marsh Best Management Practices (BMP) manual will serve as a guide for restoration and enhancement activities on Suffolk County salt marshes, with a focus on mosquito management. The BMPs recommended in this manual are designed to modify larval habitats in the salt marsh so that they are no longer suitable for mosquito production, thereby controlling the insects in their immature mosquito stages, before they can emerge as adults. These techniques, known as "source control," reduce the need for widespread pesticide applications. Integrated Pest Management (IPM), the philosophy espoused in government directives and guidances regarding insect control, stresses that source control is preferred over pesticide use.

Salt marshes are highly productive ecosystems that perform many functions, including but not limited to:

- nutrient and organic matter production, alteration, and transport;
- nutrient and contaminant sesquestration;
- buffering of wave energy;
- flood water storage; and
- sediment trapping.

Salt marshes and their near vicinities provide critical habitat for the larval and juvenile stages of many fish and invertebrate species, and are used for spawning by many species. In addition, salt marshes serve as important feeding and nesting grounds for many birds, especially migratory species, and also are habitat for other terrestrial vertebrates.

Salt marsh vegetation forms distinct zones in response to a combination of factors. In the northeast US, low marsh vegetation, which is inundated on every tide, is typically covered by one grass, *Spartina alterniflora*. The high marsh is that area that is irregularly

flooded by tides. It typically supports *S. patens*. Other salt-tolerant plant species are found in the high marsh, and also grow from the high marsh zone up into the beginning of the uplands, which is where more typical terrestrial plants are found. Factors other than the frequency of tidal inundation that affect vegetation patterns include soil and groundwater salinity, the availability of nutrients, and the quality of the underlying sediments.

Long Island salt marshes are on the southern border of what is known as the New England type of marsh. New England marshes tend to be small in comparison to the very large expanses of marshes found in southern states. They are found on the glaciated coastal plain, and are marked by sediments composed both of inorganic marine materials and marsh peat. Typically, sediments contain little material from the surrounding uplands. Salt marshes in Suffolk County are present in North Shore embayments, all throughout the Peconic estuary, and on the barrier island, bay islands, and along mainland tidal creek and river shores in the South Shore estuary system. Tidal ranges vary greatly among these areas, ranging from microtidal (0.2 meters in the South Shore Estuary at Bay Shore), to more mesotidal ranges, especially along the North Shore (0.7 meters at Montauk Point and Plum Gut and into the Peconic Estuary, and 2.0 meters near Port Jefferson). Long Island salt marshes are described as a key element of the North Atlantic Flyway, the East Coast pathway followed by migratory birds, especially waterfowl.

Several species of mosquitoes breed in salt marshes. One species tends to be dominant – *Ochlerotatus sollicitans*, the salt marsh mosquito. Mosquitoes need standing water for larval development, and so slight depressions where water accumulates, and neglected ditches or other still waters, can breed millions of mosquitoes during the course of a summer. The timing and quantity of mosquitoes produced is a function of time of the year, and the timing and amount of standing water. Salt marsh mosquitoes, for example, lay eggs on moist mud within shallow depressions in areas of high marsh, typically dominated by *S. patens*. Very small potholes can be formed in this area due to the typical growth pattern of *S. patens*. It grows in small clumps that trap sediments, and these patches of vegetation become elevated above the more general marsh surface. Larger open areas, pannes, form because of vegetation smothering by wrack, ice rafting of

vegetation, hypersaline conditions, and other marsh processes. Salt marshes typically have hundreds to thousands of these pothole areas and pannes. They lie above the reach of daily tides, but precipitation and/or lunar high tides can fill them with water. The water serves as a cue for the mosquito eggs to hatch. After hatching, salt marsh mosquito larvae develop quickly and reach the pupal stage in about 1 week. Increased temperatures accelerate the process which allows the mosquitoes to emerge as adults before the temporary pools dry down. Adult mosquitoes, fly inland for a blood meal and return to the marsh to lay their eggs on the moist mud left in the pothole depressions. The next lunar tide repeats the cycle producing the next brood.

Historically, source control in salt water habitats was addressed in three ways that are no longer viewed favorably, due to environmental considerations. These were filling marshes, constructing impoundments that flooded mosquito habitat, and the construction and maintenance of a system of grid ditches. Filling salt marshes, and grid ditching what then remained, was the preferred means of managing salt marshes in the northeast US. Approximately 95 percent of Suffolk County's salt marshes were grid ditched in the 1920s and 1930s. Grid ditches were constructed as a system of straight, parallel ditches set a fixed distance apart. This fixed pattern was relatively easy to lay out and construct, but generally was not related to natural features in the marsh, such as vegetation type or mosquito breeding sites. Grid ditches were believed to disrupt the hydrological processes that resulted in optimal mosquito breeding conditions by draining water from the surface of the marsh. However, it is also clear that ditches allowed more access to the interior of the marsh by insect-consuming fish (typically *Fundulus spp*. [killifish]). Especially where tide ranges are low, as on the south shore of Suffolk County, the predation by fishes is likely to have been much more effective for mosquito control than any effects from draining. Over the years, the grid ditch pattern was sometimes augmented by additional ditches intended to address specific breeding sites; the current ditch network consists of the original, 1930s grid plus additional ditches added over the decades.

Recent research at two South Shore marshes indicates that grid ditching of marshes appeared to coincide with vegetation changes. The changes were not exactly the same at both, probably because of other alterations to the marshes' general surroundings

occurring at the same time. At Wertheim National Wildlife Refuge, there was a general change from fresher vegetation to more salt tolerant and low marsh species. At Seatuck National Wildlife Refuge, salt tolerant high marsh plants replaced both low marsh and fresh water species. These data might be interpreted as resulting from the marshes becoming saltier, but not apparently much drier (drier marshes might have supported vegetation associated with the upland fringe). This research suggests ditches may have enabled salt water to penetrate further into the marsh, and, in some places, to be more persistent. This would have allowed fish greater residence time in areas where mosquitoes breed. Thus, if these interpretations are correct, insofar as ditching was effective in terms of mosquito control in lower tidal amplitude environments, it appears to be due to predation rather than drying of breeding locations.

The most obvious impact from grid ditching is the linear construction of the ditches, which are obviously anthropogenic in nature and foreign to a natural marsh setting. Other impacts appear to be marsh- or setting-specific. They include draining of surface water features, loss of waterfowl and muskrat habitat, loss of other wildlife (such as seaside sparrows) because of habitat alteration, encroachment by *Phragmites australis* from the marsh fringe out into the tidally-inundated areas, expansion of woody plants into the marsh, and other alterations of marsh vegetation regimes. It has been alleged that ditches serve as a conduit of upland pollutants to the estuarine system, bypassing potential treatment in the marsh.

Ditches tend to be persistent features in a marsh. Some ditches do fill or otherwise transmit water poorly. This has been addressed by periodically maintaining the ditch system by reconstructing them back to original dimensions. This kind of ditch maintenance is sometimes called standard water management. This is because the intended benefit of a maintained ditched marsh is fewer adult mosquitoes. Evidence that maintaining a ditch system is beneficial is, however, mostly anecdotal. These reports compare the initial conditions following ditching to times on Long Island when the ditches were not well maintained. Modern records indicate that complaints decrease in areas near marshes that have been recently maintained. New Jersey light trap data, although these traps are monitored regularly, and are set at fixed locations as a rule, are

generally not appropriate to use in this context, because most traps measure area production of mosquitoes. They generally do not reflect the mosquito production of a particular marsh. Ditch maintenance is usually conducted at specific marshes, rather than at all the marshes in a particular area. In addition, such comparisons are hampered by ditch maintenance recordkeeping, which has focused on machine and staff effort, and tended not to document work done in specific locations or in specific marshes. However, in areas or times where ditches are not maintained, mosquitoes appear to proliferate. Therefore, although quantitative assessments of the effectiveness of ditch maintenance are essentially non-existent, mosquito professionals on and off Long Island are convinced it is a means of reducing mosquito numbers. This, coupled with regulatory limitations on other forms of water management, accounts for the persistence of ditch maintenance as a means of water management on Long Island. Other northeast US mosquito control agencies tend to use other means now, mostly because alternatives are allowed, and even promoted, in most jurisdictions.

Other benefits cited for ditches include increases in potential fish habitat within a marsh, increases in ecologically valued edge habitat, and increases in the level of connectivity between the marshland and the estuary.

In salt marshes, there do not appear to be any effective predators of adult mosquitoes; dragonflies are said to consume large numbers of mosquitoes, but there is only one species of salt marsh dragonfly in New York State. Some bats and birds are sometimes said to predate mosquitoes, but studies indicate other prey suit insect seeking predators better, as mosquitoes are very small and somewhat difficult to capture on the wing. Mosquito larvae are consumed by a number of predacious aquatic insects, a wide variety of predatory fishes, and few species of predacious mosquito larvae (although none occur in salt marshes). Fish are probably the most efficient predators of mosquito larvae and have the ability to completely control mosquito larvae if given ample opportunities. Particular larval habitats can regulate the scope of predators that prey on the immature stages of individual mosquito species; in salt water habitats, for example, insects (e.g., dragonflies) are negligible predators on mosquito larvae, and less important for adult predation. Certain fish, on the other hand, can thrive in the shallow water environments

that favor larval development, and also are very tolerant of the poor water quality that is often found in these areas – water in ditches and marsh creeks can be warm, brackish, contaminated by noxious chemicals such as hydrogen sulfide, and low in dissolved oxygen. Altering a marsh enough so as to create the minimal water quality needed by killifish has been found to be extremely effective at controlling mosquito problems.

Due to regulations established through the Clean Water Act (1972), but also because of increased awareness of benefits associated with marshes, coastal zone management plans have sought to balance mosquito control and the restoration-preservation of one or more marsh features, such as fish or bird habitat, plant communities, or estuarine water quality. Water management, as source reduction, is intended to reduce the need for pesticide applications, and has been found to be effective in other jurisdictions. There are many water management implementation choices, however, and so it is necessary to determine which forms of water management, under what conditions, have the least amount of environmental impact, and are most appropriate for the identified problem.

The Long-Term Plan planning project has identified 15 means of salt marsh source reduction. These management activities range from allowing natural processes to control marsh features to techniques that involve major physical alterations to a marsh. It is an axiom of this manual that the management technique selected should be the most ecologically benign technique or combination of techniques for the conditions at a particular site. This can be achieved by establishing a goal to preserve, or even increase, acreage of coastal wetlands, including vegetated tidal wetlands, and to foster marine and estuarine biodiversity and a mosaic of ecological communities.

The management activities are categorized into three classes according to the amount of impact associated to a marsh:

- no or minimal impact
- minor impact
- major impact

Reversion is to be the presumptive interim action for County Wetlands, pending identification of a preferred active restoration plan for each wetland.

Class I activities are those that have no or minimal impact. They are:

- Natural processes (reversion/no action)
- Maintain/repair existing culverts
- Selectively maintain/reconstruct existing upland/freshwater ditches

Class II activities are intended to have minor impacts. They are:

- Selectively maintain/reconstruct existing salt marsh ditches
- Upgrade or install culverts, weirs, bridges
- Naturalize existing ditches
- Install shallow spur ditches
- Back-blading and/or sidecasting material into depressions
- Create small (500-1000 sq. ft.) fish reservoirs in mosquito breeding areas

Although ditch maintenance is the first technique listed under the minimal action list, it is not expected to be a primary means of water management for the County (estimates of ditching maintenance activity under the Long Term Plan are in the range of 50 acres or so a year). Maintenance of ditches will only occur under well-defined conditions, subject to local concerns and input. However, because of the ubiquitous nature of ditched marshes in the County, selectively maintaining ditches, primarily to promote better fish habitat where mosquito breeding is occurring, is a highly conservative action that maintains the status quo in the treated marsh. This means it generally represents little change from existing conditions, and so presents very little in the way of environmental impacts. It also might be suggested that opportunities for environmental benefits are similarly limited, however. Any proposed ditching maintenance will only be conducted of the

conditions in the marsh represent a public health risk by fostering excessive mosquito breeding, or if reducing the mosquito breeding will result in pesticide application reductions, and in consultation with the SCDHS Office of Ecology.

Class III activities require large-scale alterations of the marsh or will greatly impact existing hydrology, and therefore have the potential to result in major impacts:

- Break internal berms such as those created by roads and paths across the marsh
- Install tidal channels
- Plug existing ditches
- Construct ponds greater than 1000 sq. ft. (largely for wildlife value)
- Fill existing ditches
- Remove dredge spoils

Every salt marsh is unique. They can be dynamic settings, and each varies in significant ways from archetypes or exemplars. These differences are the result of hydrology, morphology, water chemistry, physical settings and surroundings, and substrate properties. Hydrology involves the presence/absence and cycling of water, in terms of quantity, form, frequency and duration. Water sources include precipitation, groundwater, rivers and streams, tides, tidal creeks, and terrestrial runoff. Salt marsh morphology is determined by elevation, slope, micro- and macro-topography, and the presence/absence of channels. Vegetation and wildlife habitat are influenced greatly by the water chemistry of a salt marsh, including salinity, temperature, nutrient content, and the presence or absence of key chemicals such as iron and hydrogen sulfide. The physical setting of the marsh can control storm impacts, overall water quality, and its overall ecological connection to its surroundings. Surrounding environments control the absence or presence of particular species, and determine the type and degree of anthropogenic impacts to the marsh. Substrate properties influence the interaction

between the hydrology and morphology of a salt marsh. The size and type of sediment particles influences water drainage and the location of the water table, and the accumulation of sediment (or lack thereof) determines whether the marsh can maintain itself in the face of relative sea level rise. These controlling factors need to be considered prior to the selection of BMP techniques.

The management activities described in this manual can be considered in the hierarchical manner they are presented in. The emphasis is on mosquito control, but control that is achieved by the means that results in the least amount of change to the marsh. It may be that in many cases greater amounts of alteration will be selected as the preferred management means for a marsh, because of the possibility for greater ranges of benefits associated with the alterations. Nonetheless, the techniques are presented in this manual from the least impact to the existing marsh, to those that represent greater changes.

Thus, the initial step prior to consideration of any management activity is to identify exactly what kind of problem is associated with the salt marsh. This manual focuses on mosquito breeding, but other problems can require salt marsh restoration, including tidal restrictions, *Phragmites australis* invasion, a need for habitat enhancement, removal of fills or spoils, or even improvements required for aesthetic purposes. However, in most cases, it seems that the more needs that are to be addressed, generally the greater the degree of alteration required.

For those proposed management actions that involve major impacts (as determined here) or include areas more than 15 acres, a formal evaluation process must be undertaken. The process is simpler for smaller projects without major impacts. Then, SCVC will coordinate with NYSDEC and the local Town on the project. Once agreement regarding project scope has been reached, and necessary permits have been acquired, SCVC will undertake the work. Post-project monitoring should be addressable between SCVC and Town resources.

The process for major projects is more involved. Once the problem has been identified, the land owner, following consultation with permitting agencies, needs to approach the County Screening Committee with a project approach. SCVC would assist in final

design of any select project. Permits would need to be acquired, and SEQRA addressed. Inherent in SCVC involvement is the intent to control any mosquito problems at the site, of course – but note that the presence of mosquitoes does not in and of itself represent a mosquito "problem," in all cases.

Management activity considerations will vary with individual site conditions. Site-specific characteristics of each restoration locale must be evaluated as part of the restoration planning. Although the impact to and the generic characteristics of salt marshes are often similar, restoration of these resources must be planned and evaluated on a case-by-case basis. A given set of designs will not be applicable to every wetland type, nor to every landowner's needs. With a detailed understanding of site conditions, however, effective management tools can be applied.

2 ESTABLISHING THE NEED AND TYPE OF ALTERATION

Establishing the need for action is the first determination in assessing Suffolk County salt marshes. Following the assessment of whether or not action is required, site-specific characteristics of the marsh must be collected to the degree necessary to determine which BMP is most appropriate for the situation.

The Wetlands Subcommittee of the Technical Advisory Committee has identified a set of goals as general management objectives for the coastal wetlands of Suffolk County. These goals and objectives have been modified slightly for the purposes of the Long-Term Plan. When establishing the need and type of alteration required for a particular wetland the following overlapping and yet hierarchical set of goals should be considered:

1. reduce mosquito populations

2. preserve or increase acreage of coastal wetlands, including vegetated; (tidal) wetlands, and to foster marine and estuarine biodiversity and a mosaic of ecological communities; and

3. control *Phragmites* and other invasive plant and animal species.

2.1 Establish a Need for the Action

Two prima facie conditions immediately establish a need for action. One is repeated or extraordinary flooding associated with water management structures under the purview of SCVC. SCVC has responsibility for mosquito control ditches installed in various salt and fresh water settings. In addition, SCVC has become the de facto maintenance organization for a variety of culverts, bridges, and other roadway water management structures. Maintenance of these structures, or problem-solving for flooding associated with them, is now the responsibility of SCVC.

Secondly, marshes that receive aerial applications of larvicides are in need of expanded water management. SCVC selects marshes for aerial larviciding when surveillance has demonstrated that large areas consistently produce mosquito larvae. Many other

jurisdictions have reduced or eliminated larvicides following progressive water management.

Other situations will require more nuanced determinations of mosquito problems. Areas that experience elevated trap counts due to brood development, where virus isolations have been made (even if in species other than *Oc. sollicitans*), and where surveillance of mosquito breeding sites show the presence of larvae, are all potential locations for water management projects. Salt marshes in the vicinity of populated areas that generate many complaints about biting mosquitoes are also candidates for source control steps.

Low population density in the general vicinity of a breeding marsh, or prohibition on management by a permitting agency will eliminate the need for mosquito control.

2.2 Pre-project Initial Data Collection

The more intensive the data collection effort is at earliest stages of a project, the more likely it is that an early determination of the scope of the project can be made. The setting of the marsh, its general physical and biological features, and the scope of the mosquito problem at the site should be documented as well as can be. Understanding the present condition of the marsh will allow the most appropriate choice of water management to be used, resulting in the least impacts.

A key element in the determination is the perception of the marsh owner/manager as to the present-day condition of the marsh, and what (if any) restoration plans may have been considered for the marsh. Those marsh owners who are generally satisfied with the present condition of the marsh, and who do not perceive a need for changes to the marsh, will be more receptive to plans that call for fewer changes. Those marsh owners that are concerned about some aspect of the present-day condition of the marsh, or who have identified restoration needs for the site, may be more interested in more intensive approaches to any mosquito problem.

Basic environmental variables should be documented to support the scope of the project. Salt marshes in Suffolk County vary with regard to several ecological characteristics such as tidal amplitude, plant species present, salinity, and distribution of open water.

Surrounding land use and overall marsh morphology can also be key features. Off-shore water quality can also be an important determinant in deciding on the kind of water management approach for a particular marsh. Information on these variables should be collected, with the scope of the effort being appropriate to the most likely BMP to be selected. Construction of a major Open Marsh Water Management (OMWM) project should require more pre-project planning than the replacement of a culvert.

It is important that the overall health of the marsh be described. There are many ways this can be determined, including a monitoring scheme described as part of the Marsh Health report in the Long-Term Plan literature search (Book 9, Part 1). The Natural Heritage Program has identified reference salt marshes across Long Island, to which proposed sites can be compared. The Long Island Wetlands Initiative has identified candidate sites for restoration, with justifications for the proposed action. The Long Island Sound Study and the Peconic Estuary Program have both set up guidelines identifying the kinds of projects that these planning efforts would likely support, and in some instances have identified specific locations for restoration projects.

One means of determining the health of various kinds of salt marshes is to determine their long-term history. This can be done by examining aerial photographs and historical descriptions. It can also be addressed by looking at long-term vegetation patterns across the marsh, and determining when and how these patterns have changed. Research supported by the Long-Term Plan has developed a novel means of analyzing photographs of Dutch corings across marsh transects to generate such information. This can be done very rigorously, using radiometric dating techniques on a few selected cores to establish marsh specific sediment accumulation rates, or more informally by assuming that, as with apparently all Long Island marshes, sediment is accumulating at or close to sea level rise rates. The determination of stable or changeable vegetation regimes does not rely on the absolute dating of changes, in any case. It should be noted that developing an accurate history for a marsh is not always simple or easy.

Minimal data collections include:

- the need for mosquito abatement, and the means by which this was determined (from complaint logs, anecdotes and experience, larval sampling, trap records)
- ownership of the marsh and adjacent land
- flow of salt water into the marsh (can include levels of inundation, determinations of tidal restrictions, surveying the salt water table, fresh water source determinations)
- health of the marsh (see above)

Further efforts can include:

- water quality of major bodies of water and tidal creeks/mosquito ditches;
- distribution of vegetation on the marsh and along the upland edge of the marsh
- wildlife surveys

2.3 Permits

One of the most essential parts of the planning process is determining what (if any) permissions from regulating agencies must be obtained prior to the project. Jurisdictions with interest in salt marshes range from local villages, towns, and town trustees, to branches of County government other than SCVC, to State agencies (especially NYSDEC and New York State Department of State). Depending on the landowner, federal organizations such as the National Park Service and US Fish and Wildlife Service may be involved. The US Army Corps of Engineers (USACOE) also has jurisdiction over any activities involving "waters of the United States," and USACOE may bring in other agencies such as National Marine Fisheries to help in the process. For this reason, addressing permitting requires understanding the length of time necessary to receive approvals of proposed plans.

The landowner, nominally, has the responsibility for obtaining all permits. However, involvement of SCVC in the project implies County interest. Therefore, in many

situations the County may be a participant in the permitting of the project. The assistance may range from technical guidance regarding filings to taking a lead role in preparing any applications that are necessary.

The Long-Term Plan planning project is intended to address many of the issues related to permitting of projects. The production of a Generic Environmental Impact Statement, which is intended to meet many (if not all) National Environmental Policy Act (NEPA) requirements as well as the State Environmental Quality Review Act (SEQRA) requirements that relate to the generation of a Management Plan for Suffolk County's vector control program, is likely to be sufficient for many aspects of permitting for water management projects. However, exactly what releases will still be required following the adoption of the Long-Term Plan by the County Legislature will be largely determined by the practical processes associated with the first few projects in conjunction with the approved Wetlands Management Plan.

It behooves the sponsor of a potential project to contact interested parties as soon as is possible. This can allow for several mutually beneficial exchanges between the proposer and any potential regulator. For one, the regulator may possess or be aware of information that will reduce the need for independent evaluation of marsh conditions. Secondly, the scope of the investigation of marsh conditions can be agreed to early in the process, avoiding excess expenditures of effort, or the frustrations of delays associated with data collection that could have been accomplished at earlier stages had the need been clearly identified. Third, interactions between project sponsors and regulators can lead to incorporation of design elements that may not have been considered without discussions of goals and objectives of the action. Finally, early interaction often reduces tensions that can arise when applications are being formally considered by regulators; often, if there has been inadequate early communication, requests for modifications to applications or permitting-related delays are not well received by an organization that is anxious to accomplish its project goals. These irritations may have been avoided if discussions had resolved issues earlier rather than later.

2.4 Salt Marsh Screening Committee

In order for SCVC to be involved in major projects, approval from the County-sponsored Salt Marsh Screening Committee will be required. This committee will have a membership comprised of County Executive and Legislature representatives, New York State permitting agencies, and local government (on a rotating basis, as determined by project locations). The Screening Committee will assess concordance of the preliminary project description with the goals and objectives of the Wetlands Management Plan. If it determines that the project meets with these goals and objectives, the applicant may then proceed onto final project design, and to apply for necessary permitting.

Certain projects, such as major alterations of significant salt marshes, may require several iterations of the initial project description in order to receive approval by the committee. One aspect that the Screening Committee will pay great attention to is the proposed scope of post-project monitoring (see below). This is an extremely important element of any project, and one that is often given short shrift.

Although the County intends to have several permitting organizations participate on the Screening Committee, initial approval of the project by the Screening Committee does not indicate that the applicant should assume future permit success with these participating agencies. These organizations are being requested to participate because of their degree of wetlands expertise, or, in the case of local municipalities, their local knowledge and awareness (which may exceed County capabilities).

2.5 Project Design

Any project with SCVC construction involvement will also require SCVC involvement in the design of the project. SCVC completely understands the capabilities of its equipment and workforce, and is uniquely suited to determine the impact of a project on mosquito breeding. For those reasons, SCVC must have a major role in designing any project where it will be requested to provide construction assistance.

Additionally, SCVC has perhaps the most experienced wetlands construction personnel in Suffolk County, and, with each additional project addressed under the Long-Term Plan, will add to that professional expertise.

SCVC's expertise will be augmented by a committee of salt marsh experts – the Wetlands Subcommittee. This committee is intended to provide a role for local government, non-government, academic, and other salt marsh experts in crafting the more complex management proposals so that they are able to meet the goals of reducing mosquitoes, fostering salt marsh ecologies, and discouraging invasive species. The committee will also report to the Screening Committee, as necessary, as information is developed through the execution of projects, so that the Screening Committee can adjust its objectives in light of practical experience.

2.6 Monitoring

All projects will require some degree of follow-up monitoring. Monitoring is intended to determine if the marsh alteration met its overall goals as a project, and especially to ensure that the action did not cause harm to the health of the marsh. In most cases, determining the former ensures that the latter will be accomplished. In some cases, regulatory agencies will require specific actions over a certain length of time. Often, for many of the less ambitious projects, it will be the role of applicant to determine the level of appropriate monitoring. Monitoring is clearly one of the elements of project design that will benefit from early and prolonged discussions with regulators and their associated interested natural resource agencies. This will ensure that an appropriate level of scrutiny to determine post-project impacts is selected, and so this level of monitoring is project-specific, and manageable for the party responsible for conducting the work.

Almost always, monitoring will be the responsibility of the landowner. Where SCVC or other elements of the County or other local government have overriding interests in the particular project, assistance may be available for monitoring efforts. There have also been expressions of interest in providing monitoring support from some of the local resource agencies, as the kinds of measurements needed to monitor the project may be part of their local environmental stewardship activities. Suffolk County will take

responsibility for monitoring marshes where reversion has been adopted as the preferred interim action. This monitoring, assumed to be conducted using remote sensing, will focus on ensuring major changes in the extent and composition of existing marsh reaction does not occur in the absence of active marsh management.

3 BEST MANAGEMENT PRACTICES

3.1 Class I: No or Minimal Impact

There are three management activities that result in no or minimal impacts to a salt marsh. These actions are classified as either "No Permit Needed" or "Generally Compatible Use – Permit Needed" in the Tidal Wetlands Regulations (6 NYCRR 661). These actions may be taken in the absence of mosquito breeding on a prophylactic basis, or because no residents are in the immediate vicinity, meaning that any mosquito breeding will not constitute a mosquito problem (assuming there are no virus isolations), or the proposed action will result in little or no impact to the existing environment. In addition, reversion (allowing natural processes to manage the marsh) is the presumption interim action in the absence of a recognized, accepted restoration management plan for the marsh. Management strategies may require alteration, however, if future development leads to greater numbers of nearby residents, or if the existing environment is otherwise found to require different management.

BMP 1. Natural Processes (reversion/no action)

This is the presumption management means, in the absence of another identified accepted restoration management plan. Natural processes can generate a return to pre-ditch hydrology and vegetation by passively allowing the marsh to return to its natural state. This should minimize impacts of ditching on the marsh – both positive and negative. Negative impacts associated with ditching include the aesthetic impacts of linear structures across the marsh and potential changes in marsh hydrology, including associated impacts to vegetation, wildlife, and marsh functions. Proponents of reversion note that ditches are obvious alterations of the marsh, and so allowing natural processes to occur may lead to a return to a natural state. Others note that allowing ditches to fill through natural processes does not mean the new condition is as natural as pre-alterations conditions were. Skeptics also suggest natural marshes were effective at breeding mosquitoes.

The success of reversion as a restoration technique is dependent on the pace and kinds of natural processes at work in the particular marsh. In some settings, ditches seem to maintain themselves. In other settings, the ditches tend to infill. This infilling process may result in the disappearance of functioning ditches within years in some instances, or it may require decades in others. Partially filled ditches may lead to more favorable habitats for mosquito breeding, and so reversion may create a mosquito problem where there once was none. Another potential issue that may arise for a partially-filled ditch system is the potential for water to not drain off the marsh surface. Some have implicated this process in the sudden die-backs of salt marshes in Jamaica Bay. Others see this as a mechanism for *Phragmites* expansion (if the water accumulating on the marsh is fresher than ambient surface waters). The National Park Service, for instance, is re-evaluating its policy on marsh reversion, as it is not entirely certain that it leads to optimal marsh conditions.

The County intends to carefully monitor all marshes undergoing reversion. The preferred methodology involves analyzing satellite photographs to determine if the total area of vegetated marsh is changing, and to look for gross changes in the composition of marsh vegetation (relative extents of low marsh, high marsh, mixed vegetation communities, and *Phragmites*). If the analysis finds a trend over three years of monitoring a site investigation will be conducted to determine if the reversion is causing adverse impacts to the marsh. If so more active management means will be relocated.

Reversion is the presumptive interim management policy for all marshes, until a more site-specific restoration management plan is adopted at each one. This is to advance a position that non-intervention in natural systems will provide benefits that exceed more associated with ecological management. Sites best suited for reversion as a permanent management process are those that are actively infilling and currently do not create mosquito problems. Reversion should be fostered where generally unmaintained systems have created stable systems that include important ecotones. For example, at Crab Meadow, the upland ends of ditches are actively infilling and vegetating, while the ditch mouths are widening and settling, creating habitat areas that are likely to support a diversity of plants and animals. Reversion may not be appropriate at sites where intervals

between ditch maintenance have led to the development of mosquito problems, especially where frequent larviciding has been required. Reversion is often considered at sites where the owner has a philosophical predilection for allowing natural processes to proceed unimpeded. More active means to achieve the general end of grid ditch removal include ditch naturalizing and filling. However, since no action is being taken, no regulatory decision is needed.

BMP 2. Maintain/Repair Existing Culverts

Culvert maintenance includes clearing blockages, replacing damaged pipes, and controlling erosion around the structure. This action is classified as "Generally Compatible Use – Permit Needed" under the Tidal Wetlands regulations, and has usually been addressed by means of a general permit. The need for maintenance is determined when unexpected flooding occurs and is reported, or by inspection. Maintaining or repairing existing culverts allows tidal flow to be maintained to the marsh, while preventing flooding. Repairing culverts perpetuates existing conditions, and so should only be considered where the existing marsh has been evaluated as being healthy.

At the time of maintenance, a determination needs to be made regarding whether the culvert is adequate for its purpose. Signs that it is not adequate include tidal lags, vegetation differences between marshes upstream and downstream of the culvert, differences in key water quality parameters between the upstream and downstream marshes, flooding history, and constrictions (indicated by excessive flow velocities in the pipe). If these factors are present, decisions need to be made as to whether upgrades to the culvert system will be sufficient to alleviate them.

Sometimes the repairs can be accomplished using hand tools, but often culvert repair will involve extensive use of heavy equipment. Culverts often pass under roadways. Repair of the culvert may necessitate road work, and so all activities may need to be coordinated with the appropriate highway department. Impacts to the marsh from culvert repair are generally minimal if restricted to the marsh periphery. More involved projects, especially where road work is involved, require planning and inter-agency coordination to ensure impacts to the marsh – and residents – are minimized.

BMP 3. Maintain/Reconstruct Existing Upland/Freshwater Ditches

Ditches were installed in freshwater wetlands generally to increase drainage and to provide a degree of mosquito control. These systems are found in some areas that are now extensively developed (such as Mastic-Shirley and Oakdale), in agricultural areas (especially in Riverhead and on the North Fork), and in areas that have very little development (such as Manorville). The primary reason for SCVC to maintain such ditches today would be to continue historical water management for flood control reasons. Ancillary to this is the reduction of standing water, which constitutes habitat, that produces flood water mosquitoes and which may occur should flooding continue unabated. The focus of efforts will be in the areas where flooding will affect residents' use of property and local streets, although some systems are also maintained in order that existing agricultural uses can continue. This means, necessarily, that the scope of the BMP is very limited. This BMP does not foresee maintenance of upland ditches in areas where residential property is not affected by flooding. An exception to this may be made if it is determined that maintained fresh water ditches are essential for spotted turtle habitat, in certain East End areas, and so provides a natural resource benefit. Such maintenance would need to be carefully conducted in order to ensure the turtles were not affected by the work, of course.

It should be emphasized that maintenance of existing ditches is not the same as installing new ditches. The County will not install new ditches under this Plan. Proposing to maintain ditches in a particular marsh does not mean that the County has any intentions whatsoever to install more grid ditches at that location.

Prior to any maintenance activities, the system needs to be inspected and evaluated in order to determine the cause of the failure. If bank erosion is occurring, for example, then reconfiguration or re-engineering of the affected area should be considered to minimize the need for continuing maintenance. It must be understood that, where these structures exist in backyards, options may be limited in terms of new configurations. Many problems associated with these systems may be reduced if homeowners can be educated so as to avoid activities that lead to flow failures – such as dumping yard waste

or other debris into the system, or creating excessive amounts of impermeable surfaces that promote run-off. It should be an operating principle that maintenance activities need to be conducted so as to reduce the potential for repeated actions in the future.

Most upland systems can be maintained by hand tools. Very often the only work that is required is the removal of debris – usually anthropogenic in nature. Where systemic problems exist, the situation is often linked to culvert maintenance or upgrades. Such maintenance situations should be carefully considered in order to develop optimal approaches to what may be persistent problems.

These ditched drainage systems may channel run-off into estuarine systems without as much natural retention, and so increase loadings of nutrients, chemicals, metals, and pathogens. Where possible, treatment of stormwater flows into these systems should be sought (as part of comprehensive stormwater management steps under USEPA Phase II Stormwater guidelines). Many of these systems are the legacy of early, less well-informed development and land-use practices, and probably would not be permitted today. However, they cannot be abandoned without significant impacts to the property of many residents, and without increasing mosquito threats to these homeowners. Fresh water mosquitoes are essential for Eastern equine encephalitis (EEE) transmission, and are believed to be the main vector for West Nile virus (WNV). Therefore, these maintenance activities, when selectively applied, are important to the maintenance of public health and the quality of life of those who live near them.

This BMP has been classified as having minimal impact because the maintenance activities are generally limited in scope – in terms of the amount of work expended on the ditches, and often in the geographical extent of the projects. These kinds of activities also are intended to maintain existing conditions. Maintenance of upland ditches is exempt from permit requirements under the Freshwater Wetlands Permit Requirement Regulations (6 NYCRR Part 663).

Table 1. Management Activities for Minimal or No Action

BMP	Action	Factors to Consider	Benefits	Impacts	Equipment to be Used	General Compatibility with Tidal Wetlands 6 NYCRR Part 661*
BMP 1.	Natural processes (reversion/no action)	- Land owner prefers natural processes to proceed unimpeded - Natural reversion is actively infilling ditches - No existing mosquito problem	- Return to pre-ditch hydrology - More natural appearance/processes - Requires no physical alterations	- Possible increase in mosquito breeding habitat, creation of problem - Loss of ditch natural resource values - Loss of tidal circulation - Phragmites invasion if fresh water is retained on marsh - Drowning of vegetation if excess water is held on marsh	Not applicable	NPN
BMP 2.	Maintain/repair existing culverts	- Flooding issues - Are existing culverts adequate for purpose? - Are existing culverts functioning properly?	- Maintain existing fish and wildlife habitats - Maintain tidal flow and/or prevent flooding	- Continue runoff conveyance into water bodies - Roads & other associated structures	- Hand tools (minor maintenance) - Heavy equipment for repair	GCp
BMP 3.	Maintain/ reconstruct existing upland/ fresh water ditches	- Flooding issues - Are existing ditches supporting flood control? - Are existing ditches needed for agricultural uses?	- Maintain existing fish and wildlife habitats and hydrology - Prevent or relieve flooding - Support turtle habitat - Provide fish habitat	- Continue runoff conveyance into water bodies - Perpetuate existing degraded conditions - Excess drainage	- Hand tools (minor maintenance) - Heavy equipment for reconstruction (rare)	NPN (6 NYCRR Part 663)

NPN - Uses not requiring a permit I – Incompatible Use GCp – Generally Compatible Use – Permit Required P – Permit Required Pip – Presumptively Incompatible Use – Permit Required NA – Not Applicable

* Local regulations may or may not be more stringent than these State regulations

3.2 Class II: Minor Impact

There are six management activities that result in minor impacts to a salt marsh. Permits are usually required from NYSDEC for these actions, although nearly all will be considered to be Generally Compatible Uses – Permit Needed, and could be addressed by a general permit. Factors determining whether these activities should be implemented at a marsh include marsh size, geographical setting, and the areal extent of mosquito breeding. Geographically restricted marshes or marshes with a small number of mosquito problems are good candidates for these kinds of restoration. The property owner will often determine if these generally limited efforts will be acceptable in meeting any predetermined restoration goals. Prior to undertaking any of the following actions, all federal, state, and local municipality regulations must be addressed. Because these actions should have minor natural resource impacts, they represent an opportunity to make rapid progress in implementing progressive water management as an alternative to the use of pesticides.

Although ditch maintenance is the first technique listed under the minimal action list, it is not expected to be a primary means of water management for the County. Ditch maintenance will only be constructed under well-defined conditions, subject to local concerns and input.

Existing water management systems (ditches, culverts, and other structures) will normally be either left alone, if not needed for mosquito control, or upgraded to BMPs as outlined in the Wetlands Management Plan. In some cases, implementation of BMPs is not immediately feasible due to lack of pre-project information or institutional factors such as landowner policies. Implementation of BMPs may also not be immediately feasible due to lack of resources. For instance, if major tidal flow restoration is desirable but is currently too expensive because it involves major road work, interim measures should be taken while these resources are sought if the alternative is a loss of habitat and/or an increased reliance on pesticides.

Assuming Long-Term Plan water management policies are implemented (especially open marsh water management), the general presumption will be against maintenance of ditch

systems. However, in limited circumstances, existing structures may be maintained on an interim basis, when the following conditions are met:

- Deterioration of or damage to structures is resulting in a significant mosquito problem, as evidenced by larval and/or adult surveillance, serious enough to require control. An example would be a collapsed pipe that restricts tidal flow and results in a need to larvicide an area. Or:

- Failure to maintain the structures would result in the loss of resource values, such as fish passage or tidal flow, or loss of vegetation due to freshwater impoundment. Or:

- Failure to maintain the structures would result in a hazard or loss of property as a result of flooding.

Benefits to be expected from the work include:

- Maintaining or reconstructing the existing structures will improve water circulation or provide fish habitat sufficient to reduce the need for pesticide application.

- Maintaining the structures is compatible with habitat values that existed prior to the failure or deterioration of the structures.

- Maintaining the structure will prevent flooding or other hazards.

Constraints on any maintenance of a pre-existing ditch system include:

- The structures will be maintained essentially in-place and in-kind.

- Disruption of wildlife habitat due to construction will be minimized by limiting work areas and/or by using seasonal constraints.

- Listed species will not be adversely impacted.

- Interim maintenance will not lead to excessive drainage that would result in a loss of wetlands values.

- The action will not lead to increased or more direct conveyance of inputs from storm drains or other structures.

- The action will not preclude the implementation of BMPs when resources and/or institutional considerations allow.

Given the above, it is expected that less than 50 acres per year will be subject to ditch network maintenance. All maintenance will be summarized in the annual water management reports, and will be conducted in accordance with a MOU with the SCDHS Office of Ecology.

It should be emphasized that maintenance of existing ditches is not the same as installing new ditches. The County will not install new grid ditches under their Plan. Proposing to maintain ditches in a particular marsh does not mean that the County has any intentions whatsoever to install more grid ditches at that location.

Ditch maintenance is found at this point in the BMP manual because this form of water management requires little change from existing conditions. Inherently, this means the maintenance of the existing ditches, especially when limited in scope, causes little to no impact to the existing system. If that system as been judged to be functioning adequately, then there will be little overall environmental impact. This does not mean that ditching is the optimal water management tool for that system, however. More progressive actions may have greater environmental benefits, through resource enhancement, for example. However, in some situations, limited actions may be determined to be the preferred marsh management approach.

BMP 4. Selective Maintenance/Reconstruction of Existing Salt Marsh Ditches (Standard Water Management)

In the 1920s and 1930s, nearly all of Suffolk County's salt marshes had a grid of linear ditches constructed across them. Although intended for mosquito control purposes, these

ditches were not targeted at specific areas of marshes that bred mosquitoes. Nonetheless, it was found that these structures reduced mosquito populations appreciably, usually by providing access for insect-consuming fish to breeding sites, but also, in instances, by draining standing water and so reducing habitat availability. The ditches tended to become clogged with debris and to infill with sediments, some more quickly than others. This meant that in order for them to continue to reduce mosquito populations, maintenance was required. It became habitual to maintain the ditch system on marsh-wide basis, rather than to target the specific ditches that were needed in order to control existing mosquito populations. This kind of maintenance was deemed to be a use not requiring a permit by NYSDEC under the Tidal Wetlands Regulations.

The installation and subsequent maintenance of the grid ditched system is believed by many to have caused damage to the salt marshes. Ditches, where they have altered marsh hydrology, certainly did affect the marshes, including having an overall impact on the water regime of the marsh, perhaps contributing to the loss of habitat for certain species, and changing the general distribution of marsh vegetation, and may have contributed to the spread of *Phragmites*. In many instances, however, marshes that are grid ditched appear to be in very good health. In fact, one complaint about grid ditching is that it leads to such vigorous marsh grass growth that it makes the marsh appear like a lawn.

Maintenance of the grid ditched system has been called "standard water management." The name indicates the role it can play in an Integrated Mosquito Management program, as the control of mosquitoes by water management means less reliance on pesticides to address problems. Ditch maintenance has been identified as a BMP because it offers the opportunity to address certian mosquito problems through source control, with the least disturbance to the existing environment. This is sometimes the best alternative as, when natural systems are manipulated, it is often impossible to determine exactly how much change will result in a cascade of deleterious results. However, it should be clearly noted that more progressive marsh management actions have been extremely successful as mosquito and salt marsh management tools, all across the Middle Atlantic States up into New England.

This proposed BMP is not to continue past measures of cleaning every ditch in a treated marsh. Ditch maintenance, as intended in the BMP, is:

- the selective cleaning of some existing ditches;
- deepening of the upstream portion of clogged ditches so as to provide adequate fish refuges from predatory birds;
- re-grading berms to allow water to access the marsh during flood tides; or
- removal of other obstacles to allow tidal flow of water over the marsh to areas of mosquito breeding.

It is to be a designed process, as the causes of ditch clogging will be investigated, and steps taken to limit repeated maintenance efforts. This may require widening stretches of selected ditches, establishing baffles to prevent erosion (through installing small curvatures in the ditch pathway, for example), and other steps necessary to make the tidal hydrology work to maintain the ditches rather than to fill them. In a few instances, the clogs will not be removed, but alterations to the upland stretches of ditch will be undertaken in order that killifish can flourish and control any mosquito breeding. The precept of this adjusted approach is to assume that not all ditches in a particular marsh will require maintenance; it may be that some ditches in the low marsh should be allowed to revert, and discretion may be in order for areas of the high marsh that show no signs of mosquito breeding. Therefore, another key step prior to the initiation of work is the identification of important breeding locations throughout the marsh, and assessment of the quality of the ditches that may allow fish access to these areas.

In general, at most sites it will be a goal to reconstruct the ditches so as to maintain tidal flows into areas that show excessive mosquito breeding activities. Good tidal flow will ensure that water quality is maintained for killifish to allow them to persist in the marsh, and reach shallow water environments where mosquitoes breed. Berms, whether naturally formed or the result of previous maintenance activity, should be breached to ensure access for fish onto the marsh, and to prevent water pooling behind these berms.

Ditch maintenance should only be conducted outside of nesting times, and when fish use of the marsh is minimal – during the winter or during late fall and early spring.

Some ditch maintenance can be done by hand; nearly all, however, is best addressed by heavy machinery, such as self-propelled, low ground pressure, rotary ditching machines. A side-benefit of their use is that spoils can be sidecast into potholed areas, and further minimize mosquito breeding.

This kind of modified standard water management, where the maintenance activities are carefully planned, and targeted to achieve maximal results, is best suited for wetlands where existing conditions meet the landowner's long-term expectations – that is, marsh functionalities meet all basic requirements, and the marsh is deemed to be in reasonably good health. The maintenance activities must also pass meter with SCDHS Office of Ecology, and address concerns and issues that may be raised by local officials. However, the marsh also must have a localized mosquito breeding problem, one that is associated with failures of the ditch system. As mentioned above, this is the most conservative means of large-scale water management, and will perpetuate existing conditions. Ditch maintenance is not appropriate for salt marshes with a history of continuing maintenance and ongoing aerial larviciding. The need to larvicide in the face of existing maintenance of the ditch system shows that some element of the remediation is not functioning properly. Either the existing grid system does not reach all of the areas where mosquitoes breed, or water quality cannot be maintained consistently, even for hardy killifish. This signals the need to take more intensive steps to address the problem.

BMP 5. Upgrade or Install Culverts, Weirs, or Bridges

The purpose of upgrading or installing culverts, weirs, or bridges is to increase tidal flow onto the marsh. This will result in mosquito control benefits, as it should improve water quality for predacious fish, and the increased tidal flow may lead to greater fish access to breeding areas. Poor water quality and reduced tidal flows are hallmarks of marshes where standard water management is often ineffective. In addition, increasing tidal flow will improve exchange between the marsh and the estuary. This, in turn, will improve access by marine species, increase salinity to favor native salt marsh vegetation (and

potentially reduce *Phragmites* extent), and increase the areas of marsh covered by each tide. Because this is a major change to the hydrology of the system, it requires a permit under NYSDEC regulations.

It must be understood that there are many potential negative impacts to this action. Increasing flow through the water control structures could drain adjacent uplands, lead to flooding of upland areas during storm tides, and short-circuit drainage from the uplands out into the estuary. Alterations in the tidal regime will affect vegetative communities present in the marsh. Salt-tolerant vegetation could be replaced by other species in areas that are no longer inundated. Pre-construction monitoring can determine the likelihood of any of these negative impacts, and other mitigations, such as self-regulating tidal gates, can be used to minimize hydrological changes while maximizing flow increases.

The need for augmenting flow through such structures can be signaled by the following problems:

- tidal lags;
- vegetation differences between marshes upstream and downstream of the structure;
- differences in key water quality parameters between the upstream and downstream marshes;
- flooding history; and
- constrictions (indicated by excessive flow velocities in the pipe).

Tidal restriction is widely recognized as the greatest problem for remaining Long Island salt marshes, and has been a driver of remedial designs. SCVC involvement in this work stems from its responsibilities for "legacy" installations, and the knowledge that better water quality invariably means more fish, which tends to restrict mosquito breeding.

As with culvert maintenance (BMP 2), heavy equipment is almost always required. If roadways are involved, coordination with highway departments will be necessary. The

greatest single impediment to these remedial projects is the coordination of resources if road reconstruction will be required or desired. Materials besides old structures may need to be disposed, due to the increase in size of the aperture(s) of the structure. Incidental impacts to the nearby marsh will need to be addressed, as well. Therefore, project planning needs to account for issues such as:

- finding a location for a suitable staging area for equipment and machinery during project;
- the exact placement of the new culvert, weir, or bridge to obtain desired results;
- management of machinery while construction is being performed in order to minimize impact;
- removal and proper disposal of spoil generated; and
- establishing a pre and post project sampling protocol to assess impact.

To limit impacts to wildlife, this type of maintenance and reconstruction should be seasonally restricted to cold weather months.

BMP 6. Naturalize Existing Ditches

Part of the common, visceral reaction to grid ditched wetlands is the unnatural appearance of the geometric precision of the ditch layout. In addition, ditches tend to have berms along their edges. These berms can develop through natural accretion, as water welling out of the ditches as the tide rises will slow as it spreads over the greater marsh surface, and the loss in velocity induces sediment deposition, as slower-moving water cannot carry larger grain sizes. Berms may also be a remnant of construction or maintenance activities, as hand-operations or mechanical equipment often deposited spoils in piles near the edges of the ditch. Berms block some flows from the ditches, serve as barriers for killifish seeking access to the marsh under lowest flow conditions, and may capture water on the panel-side of the berm where it will create good mosquito

breeding environments. Naturalizing existing ditches generally consists of incising meanders to create sinuosity across the straight-line existing plan. These meanders will break through the berms, establish a less linear environment, and may change the hydrology of the existing ditches by altering the rate of flow. Naturalizing the ditches is the use of techniques of deepening, shoaling, widening, narrowing, and creating meanders in the otherwise regular ditch network, in conscious mimicry of a natural stream path.

Naturalization of ditches will generally have small effects on mosquito breeding, and so is a technique best used to augment other means of controlling breeding. It also can be a choice made in the service of other marsh issues – such as aesthetics – while not ignoring concerns regarding mosquito breeding.

One potential technique could impact mosquito breeding directly. That is the incision of deeper, or deeper and wider areas, in a grid ditch layout, to provide additional refuges for killifish from wading bird predators. This may allow for the killifish to remain on the marsh longer and more successfully, which should increase their predation on any mosquito larvae in the general area.

Changing the hydrology of the ditches has benefits and risks. Meandering streams often have erosive patterns where the inside bank erodes and the outside bank has deposition (because of the velocity differential in the path lengths). The peat of the marsh is likely to be resistant to these impacts – as is demonstrated by the persistence of natural marsh channels and many ditches. Greater sinuosity can lead to more diverse micro-habitats, and create small areas of cover, which can lead to greater wildlife use of the channel. Meanders will increase streambed length, which should lower overall velocities of the tidal prism. This may encourage infilling, or may result in more natural dissipation of tidal energies. Net effects of naturalization will be difficult to determine a priori; this restoration approach will need close monitoring to ensure it does not devolve into unintended impacts.

Minimalist naturalizations involve only breaching berms. Creating small breaches in existing berm may be done with hand tools, and only mildly affects the appearance and

functioning of the existing ditch. The taper of the ditch can be softened, in another less intrusive form of naturalization. Although many natural marsh ditches have vertical banks, some find the appearance of the straight-sided, flat-bottomed grid ditches to be offensive. In addition, studies have shown steep sides impede fish access to the marsh surface. Therefore, tapering the edge of the ditch can be undertaken, using a low ground pressure ditching machine with side casting capabilities, preferably one with the ditcher mounted on a moveable arm to minimize movement and impact to wetland. Full-blown installation of meanders requires a low ground pressure ditching machine, and this work is most practical with a moveable arm ditcher. The use of heavy machinery would restrict these actions to cold weather, when impacts on wildlife should be less.

If this action can be classified as a modification of existing ditches than it would not require a permit under the Tidal Wetlands Regulations. If it is deemed the construction of new mosquito control ditches, it would be classified as Generally Compatible Use – Permit Needed.

BMP 7. Shallow Spur Ditches

Spur ditches are an effective means of extending the impact of water management structures into the heart of mosquito breeding areas. This is a lesser impact means of attacking persistent mosquito breeding, where standard water management has not succeeded in reducing larvae presence to avoid larvicide applications. Spur ditches are shallow, narrow waterways that connect ponds, channels, or ditches to areas of known breeding. The intent is to allow more frequent access by killifish to the areas where mosquitoes are known to hatch, without all of the impacts associated with a full-depth ditch. Spur ditches can also be used as means of connecting ponds and pools to channels and ditches, and yet the shallowness of construction ensures that water will remain in the pools and ponds even at low tide. This enables these bodies of water to be hydraulically connected to the estuary without drying during tidal cycles. This means they can continue to serve as fish habitat throughout the tidal cycle, and so support more robust fish populations within the marsh. The connection to the estuary may result in better

water quality in what might otherwise be an isolated water body, with the potential for stagnated water quality.

Construction of spur ditches can be accomplished by either hand or with the use of machinery, dependent on several factors (i.e., site accessibility, length of ditches to be constructed, disposal of spoil, and the presence of a substantial vegetation to prevent erosion of existing marsh surface). The use of hand tools is practical for small spurs and creates minimal impact to the wetland; hand work is not usually seasonally restricted. Longer spur ditches should be constructed by machine. The cutter head should be as small as possible, as that minimizes the chances the operator will cut too deeply.

It may be possible to classify the construction of spur ditches as the maintenance of existing water management structures, which would not require a permit under the New York State regulations. However, it is more likely that spur ditch construction will be classified as new ditch construction, and so a permit may be required (although it should be considered a Generally Compatible Use – Permit Needed).

BMP 8. Back-blading and/or Sidecasting Material into Depressions

Spartina patens tends to grow in groups of plants, so that it forms raised areas above the general elevation of the marsh. This creates small potholes – "ankle-busters" – familiar to all who have walked across a South Shore marsh. These small potholes are very effective mosquito habitat, because the area where *S. patens* thrives is not regularly flooded, but rather only is covered by water on the higher monthly tides. Salt marsh mosquitoes need this kind of irregularly flooded terrain for eggs to mature; they also require standing water for the larvae to grow in. The potholes, especially in dense vegetation where evaporation may be limited, serve this function well.

Larviciding can have limited effectiveness in such areas. The small potholes tend not to be hydrologically connected at all times, so the pesticide needs to reach each little area to attack the larvae. Vegetation cover may hinder this. The limited fish habitat provided in the ditches may mean that fish may not be as adventurous in seeking out the farthest potential sources of food, if they must also retreat with receding tides. Ponds and spur

ditches may provide either more secure high marsh fish habitat, or better access to these potholed areas. However, it is not clear that all potential breeding habitat can be accessed no matter how dense the network of ponds, channels, and spur ditches is.

Elimination of the potholed areas does provide a clear solution to breeding in these areas. Spreading material out to smooth the micro-topography is successful when the wet marsh sediments are used for this task, as their plasticity makes them good at filling nooks and crannies under the plants. The application of several inches of sediments rarely has any deleterious effect on existing vegetation, as the plants are limber and rapidly spring back or sprout through the surficial application, depending on the time of year. Other jurisdictions have noted that these kinds of applications of sediment often encourage spreading of *S. patens*, thereby reducing the clumping effect that was responsible for the development of the pothole terrain. The depth of material for rapid plant regrowth is on the order of several inches. Where sediments are spread more thickly, as is common in some New Jersey applications, for example, it may take several growing seasons for full recovery to be realized. However, it has been generally found that even smothered marshes will revegetate with the applicable plants associated with the hydrology, meaning *S. alterniflora* dominated communities for regularly flooded areas, and *S. patens* communities where irregular flooding is maintained – these projects sometimes cause changes in overall flooding patterns due to hydrological modifications. The process is slowest when asexual propagation via runners, rather than resprouting or seed dispersal, is the predominate means of pioneering the resedimented areas.

The source of the material can be ditch maintenance or the construction of channels, spur ditches, or ponds. The material can be applied either directly via sidecasting from a ditching machine, or through various blading techniques by low ground pressure equipment.

There are some concerns regarding this habitat elimination technique. Application of excessive amounts of material could elevate the marsh surface, creating drier conditions which could encourage undesired vegetation changes such as encroachment by *Phragmites* or shrubby upland vegetation. The depth of material across the marsh surface

must be limited to a depth where it can be "absorbed" without an overall change in the elevation of the marsh surface, as even minor changes in the elevation will enhance competitive exclusion, especially by *Phragmites*. Damage to roots can occur through too frequent tracking across the area being treated, and ruts are always a concern, even with low ground pressure equipment. Seeding is one approach when pannes are filled; in New Jersey, without seeding, pannes will vegetate, but it often requires years for the natural vegetation to seed or spread to the area by runner. Use of sediment where *Phragmites* has colonized has the risk of spreading *Phragmites* by sidecasting seeds or rhizome pieces. Thus, not all sediment may be suitable for redistribution.

Either technique (sidecasting or back-blading) requires the use of heavy equipment and therefore is time sensitive. Impacts to flora and fauna must be evaluated prior to commencement of either of these actions. Low ground pressure, side casting ditching machines with a back blade apparatus attached would be the preferred machine for these actions. The back-blade attachment would allow for "touch-up" of the side-casted material.

The technique that generates this material will determine its regulatory status. If generated from ditch maintenance activities, no permit is required. If the material is generated by construction of channels, spur ditches, or ponds, the regulatory status of each of those actions will apply to the management of sediment generated by them.

BMP 9. Small (500-1000 sq. ft) Fish Reservoirs in Breeding Areas

It is believed by many that the construction of grid ditching fundamentally altered marsh hydrologies, with the main impact being the loss of surface waters from the marshes. There are many examples where this is the case. There may also be approximately as many examples where the loss did not happen, according to contemporary accounts, or where modern grid ditched marshes support an array of surface water features. Nonetheless, one intent of OMWM techniques is generally to establish ponds and pools on the marsh surface. These are intended to be fish refugia. When breeding problems are intractable under standard water management, provisions to ensure fish presence on the high marsh need to be implemented. This may be the least intrusive, and most natural

appearing of the potential means for achieving better fish habitat. New Jersey has had great success in reducing larviciding over large areas of high marsh through similar actions. Ponds are optimally placed where mosquito breeding occurs. This can lead to conflicts with vegetation specialists, or with marsh managers where wetlands are measured in terms of vegetated acreage (as is the case in New York). Replacing vegetated wetlands, almost always high marsh, and very often *S. patens*, with open water features leads to a loss of wetland acreage (according to that definition). That is a violation of many policies and precepts, and, in New York, of State law. The construction of very small ponds ameliorates this impact, as the loss associated with any one pond is negligible. Based on New Jersey data, it can also be shown that Long Island marshes nearly all have much less open water than is usual for natural marshes (open water should be 20 to 25 percent of the entire surface area). Thus, arguments can be made that small ponds have no discernable impact on overall marsh acreage, and merely make a small dent in the overall open water deficit found for most County marshes.

Small fish reservoirs make for major habitat improvements for insect consuming fish that voraciously feed on mosquito larvae. These reservoirs should be constructed in areas where potholes or breeding pannes occur. Sites should be chosen that have little or undesirable vegetative cover. The pond should have a cross-section in the shape of a saucer or spoon, with a maximum depth of 30 to 36 inches. Reservoirs should have gentle slopes and offer shorebird foraging areas, ranging in depth from six to 24 inches. A sump should be located within the reservoir, with a maximum depth of 30 to 36 inches deep to provide a refuge for fish.

The excavated material can be used to either fill ditches, or to fill potholes and other breeding areas. If ditches are to be filled, then an excavator must be used (in conjunction with a dump-body hauler). The top layer of vegetative matter should be stockpiled, and set in the ditch last, in order to jumpstart the revegetation process. If ditches are not to be filled, the material can be spread across mosquito breeding habitat. This habitat is characterized by the presence of potholes and pannes. Thin layers of material can be spread to fill these areas where water collects; the physical material prevents water from accumulating, and it may also encourage the spread of root mat material from typical

clumpy *S. patens* patches. The material can either be spread, if an excavator is used for the pond, by back-blading with grading boxes, or using bulldozer blades. Alternately, the pond can be dug using a ditcher with a swivel head. Fixed arm ditchers can also be used, but care needs to be taken that multiple track swaths do not lead to excessive ruts on the surface of the marsh.

It is very important that pond construction be carefully planned. Pond locations should be located in areas of demonstrated mosquito breeding. The ponds should be staked out clearly, and the overall design plan adhered to. There should be design consultation with resource specialists to optimize ancillary benefits – such as water fowl use, or wading bird habitat values.

It is clear that pond construction requires heavy machinery, and will need associated restrictions regarding seasonal construction windows and site accessibility. Although New Jersey has had good success with year-round construction, frozen marshes will limit tracking impacts. In addition, unless ditches are to be filled, it is preferable to use low ground pressure rotary ditching machines with side casting capabilities. In addition, the rotary ditcher should be attached to a moveable arm in order for the action to be completed with minimal amount of movement, reducing the impact on the wetland.

One interpretation of the Tidal Wetlands Regulations is that this kind of BMP is an extension of standard water management techniques. Therefore, it could be viewed as akin to the construction of new mosquito control ditches, and so would be treated as Generally Compatible Use — Permit Needed.

Table 2. Management Activities for Minor Impacts

BMP	Action	Factors to Consider	Benefits	Impacts	Equipment to be Used	General Compatibility with Tidal Wetlands 6 NYCRR Part 661*
BMP 4.	Selective Maintenance/ Reconstruction of Existing Salt Marsh Ditches	- Local government issues and concerns resolution - SCDHS Office of Ecology review - Mosquito breeding activity - Land owners long-term expectations - Overall marsh functionality - Ditch maintenance is to be selective and minimized	- Enhance fish habitat - Maintain existing vegetation patterns - Maintain existing natural resource values - Allow salt water access to prevent/control Phragmites - Reuse pesticide usage	- Perpetuate ongoing impacts from ditching	- Hand tools (minor maintenance) - Heavy equipment for reconstruction	NPN
BMP 5.	Upgrade or install culverts, weirs, bridges	- Flooding - Flow restrictions - Associated marsh impacts - Cooperation from other involved departments	- Improve tidal exchange and inundation - Improve access by marine species - Increase salinity to favor native vegetation - Improve fish habitat & access	- Negative hydrological impacts - Changes in vegetation regime	- Heavy equipment required	GCp
BMP 6.	Naturalize existing ditches	- Grid ditches - Mosquito breeding activity - Landowner needs - In conjunction with other activities	- Increase habitat diversity - Increase biofiltration - Improve fish habitat and access by breaching berms	- Hydrology modification - Minor loss of vegetation - Possible excess drainage	- Hand tools (minor naturalization) - Heavy equipment for major	NPN/GCp
BMP 7.	Install shallow spur ditches	- Mosquito breeding activities - Standard water management not successful (continued larviciding)	- Increase habitat diversity - Allow higher fish populations - Improve fish access to breeding sites	- Drainage of ponds and pannes - Hydraulic modification - Structure not stable	- Preferably hand tools	NPN/GCp
BMP 8.	Back-blading and/or sidecasting material into depressions	- Mosquito breeding activities - Standard water management not successful (continued larviciding)	- Improve substrate for high marsh vegetation - Compensate for sea level rise or loss of sediment input - Eliminate mosquito breeding sites	- Excessive material could encourage Phragmites or shrubby vegetation - Materials eroded so that application was futile	- Heavy equipment required	NPN or GCp
BMP 9.	Create small (500-1000sq. ft) fish reservoirs in mosquito breeding areas	- Mosquito breeding activities - In conjunction with other water management - Natural resource issues	- Increase wildlife habitat diversity/natural resource values - Improve fish habitat - Eliminate mosquito breeding sites - Generate material for back-blading	- Convert vegetated area to open water with different or lower values	-Heavy equipment required	Status Undetermined

NPN - Uses not requiring a permit
GCp – Generally Compatible Use – Permit Required
Pip – Presumptively Incompatible Use – Permit Required
I – Incompatible Use
P – Permit Required
NA – Not Applicable

* Local regulations may or may not be more stringent than these State regulations

3.3 Class III: Major Impact

There are six management activities that result in major impacts to a salt marsh. Application of these techniques requires a clear understanding of the marsh being treated, and careful consideration of potential impacts. Because the potential for major impacts exists, these techniques should only be employed when a serious mosquito problem exists, or in the service of other overriding concerns of the landowner. In many instances, these BMPs offer the opportunity for significant natural resources enhancement.

The potential for impact increases the scrutiny of these kinds of projects. It is likely that the permitting process will be more complex and involve more parties than the less impactful measures discussed previously. Interested parties in such actions include NYSDEC, USACOE, and local agencies such as towns and town trustees. While the County may have an interest in assisting in the permit process, as mentioned earlier it is the responsibility of the landowner to collect approvals from all interested parties.

BMP 10. Break Internal Berms

In some instances, substantial levees, berms, roadways, or dikes have been constructed that hydraulically isolate part or all of the salt marsh from part or all of tidal flow. This impacts water quality, making it difficult for insect-consuming fish to maintain themselves. This also may result in shifts in vegetation patterns. It is especially supportive of *Phragmites* invasions, as *Phragmites* does best when water conditions are less saline.

The considerations associated with improving culverts apply in this condition. However, because the modification of exiting hydrology is much greater (in most instances), and often affects larger areas of marshland, these decisions must be made carefully with much planning. Breaking internal berms, such as those along ditches or those created by roads and paths across the marsh, will improve fish access to mosquito breeding sites as well as prevent stagnant water where mosquitoes are likely to breed. By implementing this technique, estuarine species may gain better access to the marsh. In addition,

waterlogging of soil and loss of high marsh vegetation may also be prevented by this action. Conversely, excessive drainage of pannes and pools and the introduction of tidal water into areas where it is not desired are potential negative effects of this technique. There may be additional impacts in terms of removal of flood protection, vehicle access, or whatever other original goals were associated with the installation of the berm.

In order to limit any potential negative effects of breaking berms, the depth of cut through the berm should be limited to that necessary to restore the desired degree of tidal connection. The same series of problems associated with culverts should be avoided in this work:

- tidal lags;
- conditions that will support vegetation differences between marshes upstream and downstream of the structure;
- differences in key water quality parameters between the upstream and downstream marshes;
- creation or support of conditions likely to result in flooding of adjacent property; and
- constrictions (indicated by excessive flow velocities in the pipe).

Tidal restriction is widely recognized as one of the more serious problems facing many of the remaining Long Island salt marshes. Because it is a visible problem where solutions appear to be easily determined, tidal restrictions have been the subject of many remedial designs. It is possible that restorations to tidal restrictions can have negative impacts, such as draining of adjacent wetland uplands, flooding of upland areas during storm tides, and potential short-circuit drainage from the uplands out into the estuary. Alterations in the tidal regime will affect vegetative communities that are present in the marsh, which may or may not be desired. Mitigations, especially such as self-regulating tidal gates (although these have been rarely implemented on Long Island), can be used to minimize hydrological changes while maximizing flow increases.

This technique would require the use of heavy machinery and the associated restrictions such as seasonal construction windows and site accessibility. Coordination with other parties associated with the berm will be required. Also, a determination of the type of equipment to be used depends on what will be done with the spoils generated from this action. If the spoil can be disposed of on site by either back blading or side casting, then a low ground pressure, side casting ditching machine with a back blade attachment will suffice. If the material needs to be removed from site, a low ground pressure backhoe and dump body truck may be required to remove the spoil from the marsh. In addition, if the spoil must be removed from the site, an upland disposal area must be located prior to commencement of this action.

A permit for this action is required under the New York State Tidal Wetlands regulations.

BMP 11. Tidal Channels

Tidal channels (salt marsh creeks) are integral features in most salt marshes. A striking feature of some South Shore marshes is the absence (or relative paucity) of such features. Tidal creeks can also be important to conduct salt water to areas of the marsh that appear to suffer from an excess of fresh water – as where *Phragmites* is expanding. In some instances, it appears that fresh groundwater discharges into the upland fringe area of the marsh, creating fresher conditions there. These channels have the potential to convey this seeping fresh water away. Tidal channels can serve as excellent fish habitat, and also can conduct good quality estuarine water into the interior of the marsh.

A tidal channel is a water body engineered to have natural features that should allow it to maintain itself, and to mimic the functions of natural marsh creeks. This means that these features will taper from the estuary to the back of the marsh, and will contain meanders, wider portions of channel, and potentially have narrower stretches. The depth of the channel can vary, as well. The intent is to facilitate the transport of estuarine water into back marsh areas and improve habitat for fish to enhance mosquito control efforts. This is accomplished by improving exchange between the marsh and the estuary. This should lead to improved access to the marsh by estuarine species, increases in marsh water table salinity to favor native salt marsh vegetation, and may result in a greater extent of tidal

inundation. These features can result in major changes to the hydrology of the marsh, and should be considered carefully. Tidal channels have the potential to cause excessive drainage of adjacent uplands, or flooding of adjacent areas during storm tides. They may also result in short circuiting of any overland flows from adjacent uplands. In order to limit these adverse effects, installed channels should be limited to tidal areas (thus the denoted "tidal channels"). A buffer between the channel and upland should be provided. A sill connector to the estuary could limit drainage from the creek during low tide. In addition, sill ditch connectors between the tidal creek and any other marsh surface waters could also promote the intentional retention of water on the marsh during lower tides.

Tidal channels are used as a supplement to other efforts to control mosquitoes. In and of themselves they are unlikely to have major impacts on breeding. Tidal channels can be a useful component of a larger project, if they meet the overarching design needs for the project. Tidal channels are expected to be extremely useful in restoring overall tidal circulation to control *Phragmites*, and will often be helpful in promoting better water quality to ensure fish presence in the high marsh. Tidal channels are likely to be important for certain wildlife habitat-focused projects, especially those seeking to improve estuarine fish use of the marsh. Tidal channels may be an essential ingredient of a marsh restoration that focuses on aesthetic improvements (such as ditch removal), or to tweak what otherwise is a "marsh reversion" project (see BMP 1).

Tidal channels will be dug using heavy equipment, and so seasonal and access-related restrictions will apply to these efforts. Low ground pressure ditching machines can be used for construction; fixed arm machines will be less useful than those that have more flexibility. Machines with flexible arms are better at constructing curved waterways. Spoils, especially if generated in *Phragmites* areas, need to be managed carefully. One possibility is to sidecast *Phragmites*-laden spoils away from *Spartina* areas, potentially directing the material into existing *Phragmites* stands. If the material needs to be removed from site or will be used to fill existing ditches on the marsh, a low ground pressure backhoe and dump body truck is required to redistribute or remove the spoil from the marsh. Also, if the spoil must be removed from the site, an upland disposal area must be located prior to commencement of this action.

These projects need to be carefully planned, with the proposed channel designed not only to determine where it should go, but the appropriate widths and depths for the various stretches of the channel need to be very carefully planned. Stream morphology consulting would be of use. Another potential tool is the wetting-drying model developed for the South Shore Estuary Reserve by the Marine Sciences Research Center, Stony Brook University. This model can be extended into adjacent salt marshes, if appropriate survey information is available, for nominal costs. Then various channel scenarios can be modeled under realistic projections of water flows even as the tidal waters rise out the creeks, and later retreat into the estuary.

It may be possible to treat such channels as new mosquito control ditches, which is classified as Generally Compatible Use – Permit Needed under the State regulations. However, it is also possible this will be classified as an essentially unclassified action, requiring a permit process absent the assumption of compatibility with the regulations.

BMP 12. Ditch Plugs

A common implementation of OMWM is to construct ditch plugs to retain water in existing mosquito ditches. In fact, until the Long-Term Plan OMWM Demonstration Project at Wertheim National Wildlife Refuge, ditch plugging had been the only kind of OMWM conducted in Suffolk County. The first effort was at Seatuck NWR in the mid-1980s. Other notable efforts with County involvement included earlier efforts at Wertheim NWR, Fireplace Neck, William Floyd Estate, and Goose Creek. The Town of East Hampton has also conducted some ditch plugging (in concert with Cornell Cooperative Extension), notably at Napeague. The plugging of ditches, as a mosquito control technique, is intended to enhance fish environments by providing refuges from predators. Ditch plugs also create tide cycle-proof habitat for fish, allowing them to remain in proximity of breeding locations, whether or not the ditches would have drained at low tide absent the plug. Some have also asserted that creating higher water tables, as may result from plugging, will reduce potential mosquito habitat through oviposition disturbance, as salt marsh mosquitoes require damp but not inundated soil to lay eggs. As a salt marsh restoration action, it is intended to restore pre-ditching water regimes, by

elevating water tables that may have been drained by the ditches. It may assist in *Phragmites* control because it potentially keeps salt water within the marsh. This is based on the concept that the water in the ditches will tend to be saltier, as salt water is denser than fresh; therefore, if there is any density separation between salty estuarine water and fresher inputs, the fresh water will be more buoyant and drain over the top of the plug first. Ditch plugging can enhance natural resource values by creating more surface water on the marsh (as noted earlier, Suffolk County marshes appear to be generally deficient in surface water percentages compared to other area salt marshes). Plugs are also expected to increase water retention time in the ditches. This could enhance any polishing impacts that occur within the marsh (this is the main impetus for East Hampton's efforts, which are said to have been successful in reducing coliform loads).

Plugs generally consist of standard size (four foot by eight foot) sheets of plywood driven into the peat to the level of the marsh surface, with additional plugging achieved with marsh spoil. Plugs are intended to be installed to the marsh surface, with final elevations attained with adequate compaction of the emplaced materials. Reserving any surface spoil for the top layer of the plug will result in quicker revegetation. Plug widths in Suffolk County historically have been on the order of three feet or so. This is generally considered to be inadequate by others employing this technique. A more progressive approach, as is generally espoused in Connecticut, would require 50 to 100 feet of plug, to reduce chances of blow outs or undermining by muskrats. Most plugs installed in the County have failed for these two reasons. The spoil required for plugging are generally obtained by deepening and widening the ditch behind the plug. Besides generating the materials required to create the necessary plug, this enhances refuges for fish from wading bird predation by providing adequate protective depths. Plugs should extend laterally onto the marsh to prevent erosion around the edge of the plug. Plugs are likely to settle with time and be impacted by water flow prior to revegetation and stabilization, and so in many cases they are often initially installed to an elevation above that of the surrounding marsh. This may not be optimal, as such steps can lead to impacts to sheet flow patterns. Backhoes mounted on low ground pressure platforms are generally used for this work; smaller plugs can be created by hand, with much effort.

Potential negative impacts on natural resources include a reduction in tidal exchange and fish diversity in ditches due to lack of access. The impoundment of freshwater is a potential negative impact, leading to freshening of the marsh and potential *Phragmites* expansion. Most experiences have indicated that the reverse, an increase in overall salinity, is more likely to occur behind the plug. Drowning of vegetation is also possible if excessive water is held on the marsh. Maintaining salty water in the marsh often leads to changes in vegetation, as *S. alterniflora* will be promoted in the areas experiencing greater inundation.

A mitigation of some of these effects is to construct sill plugs, rather than plugs installed to the top of the marsh. Sill plugs terminate some distance between the surface of the marsh and the low tide level – usually on the order of six to 12 inches below the general marsh surface. This means that tidal exchange is not dependent on over-marsh flows, but will occur on every tidal cycle, or nearly so. Sill ditches need to be designed so that the volume of water released during lower tides is not so great as to cause continuing erosion of the sill. Sill plugs may be a sounder choice for where lower tidal ranges predominate, in order to ensure there is adequate water quality within the ditches, given the smaller tidal prism and therefore overall smaller exchange rates on each tidal cycle.

However, open (no plugs), semi-open (sill), and closed (full plugs) OMWM efforts have generally been shown to be effective mosquito control techniques in all environments. Jurisdictions from Maine to Maryland have installed varying OMWMs. Of the jurisdictions most avidly pursuing these ventures, plug techniques have been favored most in Connecticut and Maine. Delaware has tended to use a variety of approaches. New Jersey has focused mostly on open systems, albeit also creating many isolated ponds. The only jurisdiction expressing great concern regarding this technique is Maryland, where endangered species habitat loss appears to have become a paramount salt marsh management issue. However, there have been few if any OMWM installations under the kind of micro-tidal regimes found on the South Shore of Suffolk County.

Broadly speaking, closed systems seem to be best suited for higher tidal regimes where surface water losses may be a grave concern, and open systems best in the lowest tidal

ranges where marsh interior water quality is a primary issue. However, a major determinant of OMWM suitability for a particular marsh is the "ancillary" concerns. Specific OMWM systems have greater or lesser advantages to meet specific landowner concerns, through the provision of different natural resource enhancement tendencies. Closed systems may not be appropriate where managers wish to encourage interchange between the marsh and the estuary, especially for finfish. If excessive water levels are a concern, open or sill systems will be better choices; where more surface water is desired, the use of ponds or closed ditches will help achieve that goal.

Ditch plugging requires good planning prior to initiation and will of course, be the fruit of collaboration among different interest groups, including permitting and natural resource agencies. Clear delineation of the location and extent of plugs needs to be made. Modeling, as with the wetting-drying model, may be of some use in selecting the most appropriate kind of OMWM.

OMWM installations require permits from NYSDEC under current interpretations of the Tidal Wetlands Regulations.

BMP 13. Ponds above 1,000 sq. ft for Wildlife Value

BMP 9 discussed the myriad virtues associated with ponds constructed into the high marsh. It may be that the property owner has an overriding need for larger ponds, as was the case with the US Fish and Wildlife Service for the Wertheim OMWM Demonstration Project. This could be to enhance water fowl habitat (as was the case at Wertheim), but other reasons could be set forth. These might include a need to mimic the general pattern in New England salt marshes of a mosaic of pond sizes (research shows that there is a general distribution for natural ponds in Massachusetts and Maine salt marshes), for example. Larger ponds need to be designed so that they maximize the intended use. Research has been conducted on how pond shape and the size of "bays" and other nooks influence waterfowl numbers on a particular water body, for example. Larger ponds may receive greater scrutiny from regulators, however, as they may be in conflict with no-net loss policies and regulations.

Larger ponds geometrically increase the effort of construction. As with smaller ponds, spoil from pond excavation may be side-cast or back bladed into depressions or used to raise ditch depths and plug man-made ditches. However, it is unlikely all the spoils can be side-cast efficiently from a larger pond, and back-blading or other forms of touch-up work will almost certainly need to be conducted. Repeated equipment passages over the same areas of marsh can lead to rutting and damage to the plant root structures. This kind of impact is much more likely for larger ponds due to the many more vehicle trips associated with excavation and spoil management. Bottom topography should be based on mimicking that associated with a series of smaller ponds, to create more micro-habitats. That is to say, uniform bottom depths are generally to be avoided, as the creation of too much deeper or shallower habitat will not benefit all of the needed or desired communities. The use of sills to encourage water exchanges is another key design determination. A sill will result in varying water levels in the pond, which is often an important element for certain wildlife use. Other species may not welcome such variations.

This action requires the use of low ground pressure machinery and the management of the spoil dictates the type of equipment required to incorporate this technique. If the spoil is to be distributed in the immediate area of the pond, the use of a rotary ditching machine with the ditching apparatus attached to a moveable arm is recommended. This type of machinery will perform the operation with fewer tracking movements and therefore less impact to the marsh surface. It is unlikely that the side-casting will be completed properly by this machine, and some remedial back-blading is probable.

If the material needs to be removed from site or will be used to fill existing ditches on the marsh, a low ground pressure backhoe and dump body truck may be required to redistribute or remove the spoil from the marsh. Also, if the spoil must be removed from the site, an upland disposal area must be located prior to commencement of this action.

Large ponds will almost certainly require a permit under the Tidal Wetlands Regulations. They need to be carefully engineered, with the exact perimeter staked and plotted in advance of construction. The distribution of shallow and deeper areas within the pond

needs to be communicated clearly with the operators performing the work. Attention to wear and tear to the immediate surroundings is an important construction element. This is often a function of vegetation type as well as the underlying substrate, as hardier vegetation may withstand traffic that more delicate vegetation cannot. Construction under frozen conditions may be optimal for larger ponds. Coordination with permitting agencies and concurrence of the landowner with project goals are essential.

BMP 14. Filling ditches

The ultimate restoration of salt marshes for many planners is to undo the grid ditch system. This can be done by filling the ditches. Such an operation is difficult to conduct without other remediation activities – the spoil for the ditch filling needs a source, and the best material for this purpose would be salt marsh sediments. In addition, removing the mosquito ditches eliminates the water management tool currently in use. Therefore, ditch filling is unlikely to be done without constructing an alternative water management system – one such as tidal creeks and/or ponds, as these can generate the large quantities of fill needed. Ditch filling may be a mitigation to meet requirements of no net loss of vegetated wetlands when surface water features are proposed.

The intent of ditch filling is to remove the visually intrusive grid ditch system, and to restore the marsh to earlier, pre-ditching conditions. This assumes that earlier hydrological and vegetation conditions will return – an assumption shared with BMP 1, Natural Processes. It is clear that this action must be a goal of the landowner. If ditch-filling is proposed for an area with an existing mosquito problem, the need for alternate water management is clear. The needs where mosquito control problems are not as difficult are unclear. Then the project becomes much more of a restoration project than a mosquito control project. This may not remove SCVC interest from the project, but it may make it less compelling as a priority action.

The filling of ditches can deny mosquito breeding habitat if the ditches themselves were habitats made through blockages that created stagnant water in them. Potential negative effects of filling ditches may be the loss of ditch habitat for fish and other estuary species, and the loss of habitat for other wildlife using the ditches. If fresh water is retained on

the marsh because the ditches were successful in draining standing water resulting from precipitation, *Phragmites* may invade the area. Vegetation drowning may occur if excessive water remains on the marsh surface. Tidal circulation may also be lost as a result of ditch filling. There is the possibility of creating new mosquito breeding habitats if ditches are not properly filled, or if filling leads to the creation of new habitats by making the marsh wetter, or by restricting fish access to breeding locations. A mitigation of some of these impacts can be to conduct selective ditch filling as part of an overall project. Ditches that do not provide circulation or other benefits would be selected to be filled. A tidal channel or features such as ponds or sill ditches can be implemented to replace functions lost by filling ditches.

Obtaining material for ditch filling is the governing factor for the type of machinery necessary to perform this operation. If the material used to fill ditches is generated from the construction of new tidal creeks, then low ground pressure backhoes and dump body machinery will be needed. In addition, the depth of fill in the ditches should not raise the marsh surface above the level flooded by spring tides.

Project planning is extremely important for this major change to the marsh. Modeling would be useful to explore impacts of altered hydrology. Careful pre-project surveys of ditch conditions and water quality will enable good choices to be made. Resource and permitting agency involvement at an early stage is essential, as is good communication of the landowner's needs to these involved agencies. All involved parties must understand exactly what will constitute a successful execution of a project like this, and determine exactly how these ends will be measured.

BMP 15. Dredge Material Removal

Dredge material disposal sites often impinge upon salt marshes. This can create uneven topography that supports mosquitoes (often those associated with the upland fringe, such as *Aedes vexans*, the floodwater mosquito, rather than the classic salt marsh mosquito). More importantly these sites constitute a blight on the salt marsh, and often impede water flows in some fashion. Thus, they are frequent targets for classic restoration actions. Therefore, SCVC will assist in removing dredge spoils from marshes, and restoring the

habitat to more standard salt marsh vegetation regimes. However, as these sites are almost never in the intertidal wetlands but rather are in the irregularly flooded high marsh, and the classic restoration would be plantings of *S. patens*, SCVC interests also include precautions to avoid the development of mosquito breeding habitat.

To limit potential adverse effects, grading should be supervised to ensure even and appropriate elevations are achieved. Consideration for the provision of fish access from good fish habitats should be included in the design – many alternatives to achieve this have been previously discussed. Good tidal exchange to help create better water quality will be important. Plantings need to be monitored to ensure that unwanted pannes do not develop, and that *Phragmites* does not take advantage of this pioneer situation to advance further. Monitoring should also include a concern for the development of slow draining puddles and pools at microtopographical lows.

The removal of dredge spoils will almost certainly be a major earth-moving operation. This kind of alteration will require permitting by interested and involved agencies, not the least of which is NYSDEC (under the Tidal Wetlands Regulations). However, a well-designed and –considered project should garner approval, given the damage done to marshes historically by filling operations, and the benefits to be reaped by undoing this kind of damage.

Different types of machinery may be needed depending on the location of the spoils and the scope of the project. The disposal of the spoils is likely to be a key issue. Beneficial reuse opportunities for such materials are generally limited – that is usually why upland disposal was originally called for. Now that the spoils are (almost certainly) dewatered, they may have applications as general fills; landfill disposal is certainly much more feasible as a thoroughly dewatered material, although it may not be the least expensive option. It may be that conventional earthmoving equipment will be appropriate for much of the work; when near-to-final grade is reached, than marsh-suitable equipment may be needed for the final stages. These kinds of decisions need to be made based on site-specific conditions.

Table 3. Management Activities for Major Impacts

BMP	Action	Factors to Consider	Benefits	Impacts	Equipment to be Used	General Compatibility with Tidal Wetlands 6 NYCRR Part 661*
BMP 10.	Break internal berms	- Water quality (poor) - Standing water (mosquito breeding) - Impacts on structural functions	- Allow access by marine species - Prevent waterlogging of soil and loss of high marsh vegetation - Improve fish access to mosquito breeding sites - Prevent stagnant water	- Changes in system hydrology - Excessive drainage of existing water bodies - Introduction of tidal water into areas not desired	- Hand tools (minor) - Heavy equipment (major)	Pip
BMP 11.	Install tidal channels	- Improve water quality - Tidal ranges and circulation - Increase salinity (invasive vegetation) - Natural resources enhancement	- Improve tidal exchange - Improve access by marine species - Increase salinity to favor native vegetation - Improve tidal inundation - Improve fish habitat	- Changes in system hydrology - Excessive drainage or flooding of uplands - Increase inputs from uplands into water body	- Heavy equipment	P
BMP 12.	Plug existing ditches	- Improve fish habitat - Tidal ranges and circulation - Prevent upland inputs - Natural resources enhancement	- Return to pre-ditch hydrology & vegetation - Reduce pollutant conveyance through marsh - Provide habitat for fish & wildlife using ditches - Retain water in ditch for fish habitat - Deny ovipositioning sites	- Changes in system hydrology - Reduce tidal exchange - Reduce fish diversity in ditches due to lack of access - Impoundment of freshwater could lead to freshening & Phragmites invasion - Possible drowning of marsh vegetation	- Heavy equipment	P
BMP 13.	Construct ponds greater than 1000 sq.ft.	- Landowner's needs - Water fowl habitat - Natural resources enhancement - Aesthetic improvements	- Increase habitat values for targeted species and associated wildlife - Improve habitat for fish - Eliminate mosquito breeding sites	- Changes in system hydrology - Convert vegetated areas to open water with different and possibly lower values	- Heavy equipment	P
BMP 14.	Fill existing ditches	- Landowner's needs - Aesthetic improvements - To restore pre-ditch hydrology - Vegetated areas	- Return to pre-ditch hydrology and vegetation - Reduced likelihood of pollutant conveyance through marsh - Create vegetated habitat to replace that lost by ditches or by other alterations - Deny mosquito breeding habitat by eliminating stagnant ditches	- Potential to create new breeding habitats if ditches are not properly filled or by making the marsh wetter - Loss of ditch habitat for fish, other marine species using ditches - Loss of tidal circulation - Phragmites invasion if freshwater is retained on marsh - Drowning of vegetation if excessive water is held on marsh	- Heavy equipment	P
BMP 15.	Remove dredge spoils	- Increase wetland habitat	- Convert low-value upland to more valuable wetland habitats - Eliminate mosquito breeding sites	- Could result in new breeding sites if not carefully designed - Major change in local topography	- Heavy equipment	P

NPN - Uses not requiring a permit Pip – Presumptively Incompatible Use – Permit Required I – Incompatible Use
GCp – Generally Compatible Use – Permit Required P – Permit Required NA – Not Applicable

* Local regulations may or may not be more stringent than these State regulations

3.4 Interim Actions/On-going Maintenance Activities

It will not be possible, following initial evaluations of the conditions at various salt marshes in the County, to ensure that the BMP most appropriate for the marsh can be installed immediately. In fact, in some cases a rather long time period may be required before the BMP can be undertaken. Fiscal realities and equipment scheduling may lead to some delays (although it is anticipated these will be relatively short-term under most conditions). Other factors that may affect the ability to conduct a BMP would be landowner unwillingness or uncertainty regarding the proposed project, and, in some instances, failures to conduct necessary public planning processes. This is an issue for the many New York State Tidal Wetlands in the County. Prior to undertaking major restoration activities there, Unit Management Plans need to be adopted by NYSDEC. It is unclear if each wetland is required to be assessed separately, or if the holdings can undergo a single unified review. It is clear that this public process generally requires a year or more to complete when full attention is given to the process. Given staffing realities and program priorities, it is unlikely that the State wetlands will undergo this planning process in the very near future.

Therefore, four Interim Management/Ongoing Maintenance Actions (IMAs) have been identified. These are generally not to be the optimal BMPs for the wetland to which they are applied. Nonetheless, the IMAS provide SCVC with a means of providing a degree of progressive water management on an interim basis until the necessary steps can be taken to conduct more appropriate BMPs at the salt marshes.

The presumptive preferred interim action is to be reversion of the marsh. It is understood that reversion may not be optimal for many of the County's marshes. Therefore, careful monitoring of all reversion rates will be undertaken. Reversion will be the adopted management action until a preferred, long-term restoration ,management plan is adopted for the site in question.

Selective ditch maintenance has been identified as an Interim Management/Ongoing Maintenance Action. This is for two reasons. One, ditch maintenance, when conducted carefully and thoughtfully, has the potential to reduce mosquito populations, primarily by

providing fish access to mosquito breeding areas. Implementation of this IMA will focus on enhancing water quality in the areas where breeding is occurring, and in improving overall fish habitat values to encourage killifish populations. Secondly, as an interim action, it has the advantage of be a minimal change to existing conditions. This means that although opportunities for greater enhancements are not being immediately realized, neither are most other BMPs being eliminated from consideration. Ditch maintenance, in this view, will constitute a holding action until a better alternative can be selected and designed.

Ditch maintenance will not expected to be widely practiced. The sum of the marshland to have ditch maintenance applied is expected to be 50 acres or less for every year of the Management Plan. In no case will ditch maintenance be conducted as had been the case at some times, where every linear foot of a marsh might be cleaned despite otherwise limited mosquito breeding in the marsh.

IMA 1. Natural Processes (No action/reversion)

The presumptive policy of the County for interim actions is to allow natural processes to occur. This is to advance a position that non-intervention in natural systems will provide benefits that exceed those associated with ecological management. However, it is also acknowledged that reversion may not be optimal for all marshes. To ensure this policy does not result in negative impacts to County's marshes, monitoring will be conducted. It is assumed that remote sensing capabilities will allow for the determination of gains and losses of vegetated wetlands at each marsh, and will be able to distinguish between low marsh, high marsh, mixed vegetation-type areas, and *Phragmites*-dominated areas. These measurements will be analyzed for trends, and if potential impacts are noted for a marsh, a site investigation will be made to determine if reversion is the cause of the problem.

Reversion, as an interim activity, is intended to serve as a bridge between past practices and a selected, long-term marsh restoration management plan. It may very well be that reversion is selected as the long-term management technique.

IMA 2. Selective Ditch Maintenance (Standard Water Management)

Ditch maintenance has been applied to the grid ditched system, with various degrees of enthusiasm, skill, and forethought, for approximately 70 years. When maintenance activities have been most frequent or intensive, anecdotal evidence would indicate that mosquito populations were reduced effectively. When applied indifferently, ditch maintenance has had a more spotty record.

It should be emphasized that maintenance of existing ditches is not the same as installing new ditches. Proposing to maintain ditches in a particular marsh does not mean that the County has any intentions whatsoever to install more grid ditches at that location.

Ditch maintenance is successful when it either helps drain breeding habitats, or provides good access for insect consuming, hardy marsh fish to the breeding habitats. It is most likely that fish predation is the more effective means of mosquito control on the South Shore. In two marsh systems with equally unclogged ditch systems, the one with better tidal circulation and associated better water quality will generally produce many fewer mosquitoes, because fish are more able to withstand the rigors of the marsh and conduct effective predation. Therefore, prerequisites for action include the identification of a mosquito problem, with continuing aerial larviciding being the number one signal of an ongoing problem, together with an inability to apply the preferred optimal BMP at the site at this time. In addition, observations need to be made supporting the need for selected maintenance to stretches of key ditches.

The technique will have five goals:

- improve tidal circulation within the marsh by removing blockages to water flow to the high marsh;
- potentially deepen areas behind clogs as a means of enhancing fish habitats;
- clean ditches that are essential for fish to reach areas where mosquito breeding is documented;

- where appropriate, naturalize the ditches (see BMP 6) so as to minimize impacts of ditching on the marsh, especially in terms of aesthetics; and,

- through careful observation, determine if some simple modifications to the existing ditch system, such as widening the mouth of a particular ditch, or blocking flow from one area of the marsh to another, could prevent the need for future maintenance.

This is not an endorsement of cleaning every ditch in a marsh because it is scheduled for such actions. Rather, selected, key parts of the ditch system will receive appropriate maintenance so that the biota of the marsh can combat the existing mosquito problem.

The preferred means of conducting ditch maintenance have been discussed in BMP 4. Those precepts hold for this IMA. The County anticipates conducting such IMAs at a rate of perhaps 50 treatment acres per year over the ten year implementation horizon. This suggests that perhaps 500 of the 17,000 acres of salt marsh in Suffolk County might receive this interim action over the course of the Long-Term Plan. Any ditch maintenance activity, even as an interim action, must undergo review by SCDHS Office of Ecology, and be subject to cooperative resolution of the concerns and issues of local agencies.

IMA 2. Culvert Repair/Maintenance when Tidal Restrictions are Apparent

Alteration of an existing culvert system when tidal restrictions or other flow problems are apparent is the preferred BMP (see BMP 5). However, these kinds of actions often require close coordination with highway departments, and may involve funding issues should major roadway reconstructions be involved. These can lead to delays of several years until the preferred action can be undertaken.

Therefore, as an interim action, SCVC will clean and maintain undersized or incorrect existing water control structures in order to alleviate the immediate problem. This IMA would follow all of the concerns and issues associated with BMP 2, except it is understood that the action will be made even though conditions indicate a better action

should be selected. When the necessary processes have been completed, then BMP 5 (or something similar) will be applied.

IMA 4. *Stop-gap Ditch Plug Maintenance*

Currently, many of the ditch plugs installed in County salt marshes since 1986 are failing or have failed. It is not intuitive that the best action for marsh health or mosquito control is to have these semi-structures in the ditches.

There are three options for these situations. One is to re-evaluate the project area, and select a BMP that will be successful. This is the preferred option. However, logistics or other impediments may make it impossible to immediately conduct the BMP at the area in question. If this is the case, then one of the following two interim actions could be undertaken.

One interim action would be to selectively maintain the ditches so as to improve water quality (IMA 2, above). A second choice as an interim action, where information exists that the ditch plugs appeared to be achieving the goals associated with the restoration project, would be to reconstruct the plugs, similarly to their original construction. Although three-foot ditch plugs are rarely identified as an optimal OMWM technique, these kinds of plugs would be re-installed as an interim measure until a more appropriate BMP can be installed. The typical installation methodology would be followed, with plywood sheets used to stabilize the plug, and a small reservoir established to provide the necessary spoil material. This is only acceptable in that these plugs are not intended to be permanent, but rather are strictly temporary actions that appear to be justified in terms of past marsh responses to the original plugs.

The County will seek to have this accepted by NYSDEC as a variant form of ditch maintenance, which would obviate the need for a permit. It may be that the regulations will be interpreted that these kinds of actions, although a Generally Compatible Use, will require a Permit.

Table 4. Interim Management/Ongoing Maintenance Actions

Interim Action	Action	Factors to Consider	Benefits	Impacts	Equipment to be Used	General Compatibility with Tidal Wetlands 6 NYCRR Part 661*
IMA 1.	Natural process (No action reversion)	Presumptive interim action	-Non-intervention in natural system	-Non-intervention in natural system	-Non-intervention in natural system	-Non-intervention in natural system
IMA 2.	Selective ditch maintenance (Standard Water Management)	- mosquito breeding activity - water quality (poor) - improve fish habitat	- Enhance fish habitat - Maintain existing vegetation pattern - Improve fish access to breeding sites - Increase fish and wildlife habitat diversity - Increase biofiltration - Improve fish habitat and access by breaching berms	- Perpetuate ongoing impacts from ditches - Hydrology modification - Minor loss of vegetation - Possible excess drainage of marsh surface	-Hand tools (minor) -Heavy equipment (major)	NPN
IMA 3.	Culvert repair/maintenance when tidal restrictions are apparent	- improve water quality - restore pre-restriction hydrology -mosquito breeding activities	- Maintain existing fish and wildlife habitat - Maintain existing flows and/or prevent flooding	- Continue runoff conveyance into water bodies - Potentially inadequate water transmission	-Heavy equipment	NPN
IMA 4.	Stop-gap ditch plug maintenance	- prevent upland inputs - increase wetland habitat - sustain fish and wildlife habitat	- Return to pre-ditch hydrology & vegetation - Reduce pollutant conveyance through marsh - Provide habitat for fish & wildlife using ditches - Retain water in ditch for fish habitat - Deny ovipositioning sites	- Reduce tidal exchange - Reduce fish diversity in ditches due to lack of access - Impoundment of freshwater could lead to freshening & Phragmites invasion - Possible drowning of marsh vegetation - Impermanent approach (likely to fail within 5 years)	-Heavy equipment	GCp

NPN - Uses not requiring a permit GCp – Generally Compatible Use – Permit Required Pip – Presumptively Incompatible Use – Permit Required
I – Incompatible Use P – Permit Required NA – Not Applicable

* Local regulations may or may not be more stringent than these State regulations

4 FUNDING SOURCES

These proposed BMPs will require resources beyond those immediately available to SCVC through its operating budget. Some equipment purchases may be possible under the County capital budget. However, grant funds such as the State EPF and EQBA generally look favorably on assisting in the purchase of machinery that will be used directly on restoration projects.

Environmental restoration funds for active projects are more plentiful than funds for planning such projects. As SCVC and the County develop a list of potential projects (which is likely to require some substantial expenditures), it may be possible to reach out to funding sources such as USACOE restoration funds, USEPA initiatives (especially given the Integrated Pest Management association for all these efforts), State bond funds, and the County Quarter-cent Fund, as all of these look favorably on supporting projects that will result in actual restoration actions. Towns and certain NGOs may be able to provide resources to assist with project planning; NGO involvement may be greater if these same organizations can recoup fixed personnel costs by assisting in project implementations. Certain towns have also indicated a willingness to assist in pre- and post-project monitoring – especially those aspects of monitoring that may coincide with existing town environmental data collection efforts. It is likely, especially for larger projects, that monitoring costs will prove to be a barrier to multiple project implementations, given current State attitudes regarding the scope and duration of such efforts.

5 EQUIPMENT AND PERSONNEL NEEDS

Suffolk County has probably undertaken as large and complex a water management project as will ever be considered under the Long-Term Plan, in the OMWM Demonstration Project at Wertheim NWR. The experiences there were used to guide the determinations made in this section.

5.1 Equipment

The determining factor for the type of machinery best suited for the operation is the kind of construction required to complete the project. The following section will discuss the type of machinery best suited for each task.

The use of heavy equipment machinery for restoration activities is required for many of the BMPs. Therefore, impacts from the use of this equipment need to be considered. A primary concern is compaction of substrate. Compacted substrate can greatly affect the survival, development, and rate of plant propagation. Compacted substrates could result in restoration failure. Therefore, all machinery used in marsh construction should be special, low-ground pressure equipment, generating less than two pounds per square inch of ground pressure. Machinery that does not conform to this specification should only have limited use, and the potential for impacts to the marsh when used must be closely monitored.

5.1.1 Types of Equipment

Rotary Ditching Machinery – In construction or maintenance projects where sediments are to be removed, and where spoil is not required for ditch filling or does not need to be removed from site, this type of machinery is indispensable. Fixed arm rotary ditchers have been used to create straight-line grid ditches and to maintain the ditch system. These machines do well at that application. However, in the creation of ponds and tidal channels requiring curved features, fixed arm types of ditching equipment are less appropriate. This is because, to reach all areas of a pond or create curves in a tidal channel with a fixed arm, multiple track swaths may be required. This excessive back

and forth maneuvering can lead to unnecessary ruts and tracks carved into the nearby marsh.

Alternately, ponds and tidal channels should be constructed using a ditcher with a swivel head attached to the movable arm of an excavator. This type of ditcher will require a minimal amount of movement, reducing the impact on the wetland.

Three sizes of round-profile (Quality Industries –type) rotary ditchers are available:

16-inch Rotary Arms – ideal for small ponds, sills channels, small tidal creeks.

24-inch Rotary Arm – ideal for small to medium ponds, sill channels, tidal creeks

36-inch Rotary Arm – ideal for large ponds, tidal creeks and ditch maintenance.

In addition, Vector Control has a Dondi ditcher attached to a swinging mount behind its Pisten Bully. The Dondi head digs a trapezoidal profile ditch approximately 24 inches wide at the top, 10 inches wide at the bottom, and about 21 inches deep. The swinging mount allows curved ditches to be easily constructed.

Excavators – This type of machine is ideal when spoil is needed to fill in existing mosquito ditches, used to fill known mosquito breeding areas such as potholes or pannes, or requires removal from site. Buckets should have removable teeth, and should be a swivel bucket. Buckets with a straight edge are advantageous in constructing ponds, because they create a smooth contour to the ponds bottom.

Standard Body with Low-ground Pressure (LGP) Tracks – A LGP excavator is a standard machine where the steel tracks have been lengthened and widened to reduce their ground pressure. It can be a very useful tool in constructing ponds, but spoil has to be removed by dump body or back-blading. The back-blading may be accomplished by attaching a movable blade to the front of the excavating machine; however, when back-blading is to be accomplished in concert with excavating, it may be preferable that the blade be attached to a separate machine, so the excavator does not have to interrupt pond construction to back-blade. A LGP excavator is more maneuverable than an amphibious excavator, and can

travel faster. However, its tracks are not long enough to span the wider tidal creeks or ditches, and it does not float, limiting its ability to reach some wetland areas.

Amphibious Excavator – An amphibious excavator is a standard machine where the steel tracks have been replaced with pontoon track that exert a very low ground pressure, and can even allow the machine to float. It is a very useful tool in constructing ponds but spoil has to be removed by dump body or back-blading (both requiring an additional machine). This machine is useful when the marsh becomes soft from construction activities. An amphibious machine can cross wide ditches and creeks or float across water bodies, but is less maneuverable than a LGP machine. It is extremely slow.

Dump-body trucks – These vehicles are extremely useful when movement of material across the marsh is needed. These machines have proved to be invaluable to fill ditches with pond spoil. Multiple trips along the same path may impact the marsh, and so monitoring is necessary. Only tracked machines should be used for this task in wetlands, but wheeled vehicles could be used in uplands, such as dredge spoil areas or at culvert sites.

Back–blading Equipment – This type of equipment can be fitted to many types of machines. Efficiency may require that the machine not be needed for other, simultaneous tasks. This equipment is very important when filling in areas of active mosquito breeding because it can take material from pond or ditch cleaning and spread out the spoils over immediate area to fill in voids that may harbor mosquito larvae.

Personnel Transporters – Small vehicles suitable for transporting personnel and small amounts of equipment about the marsh are extremely useful. These machines remove the need for larger equipment to leave work sites at break times, thus minimizing heavy equipment trips across the marsh, and can save time because many of the larger machines move very slowly, requiring more time to traverse the marsh. Personnel transporters allow inspectors to move about the marsh when conditions are not favorable for

movement on foot, such as after heavy rain, during high tide flooding, or across areas that have been extensively reworked.

5.1.2 List of Equipment

A major project such as the Wertheim NWR OMWM almost certainly would require more equipment than could be expected to be available through County resources. In such cases, items not owned may be available through loans, rentals, and informal arrangements with area agencies and NGOs. US Fish and Wildlife Service, Nassau County, and Ducks Unlimited all own appropriate low ground pressure equipment that may be suitable for some or all projects, and may be available for local projects.

The following equipment is presently owned by SCVC:

Pisten Bully – The piston bully is the most versatile of all equipment owned by SCVC. It has the ability to back-blade, dump, and ditch, including the construction of curved ditches. It also is one of the faster moving machines and is very valuable when being used as a dump body machine for filling ditches. Its low ground pressure is important, leaving few ruts on the marsh surface except for the softer areas.

Large (200 hp) Quality Amphibious Ditcher – This machine has the least versatility. It is good for cutting straight runs in ditches, and its 36 inch cutter head can move a lot of material quickly. The fixed position of the cutter, behind the machine, limits its ability to cut curved ditches in its current configuration. Options to improve its ability to follow curves are being explored, such as reversing the mount so that the cutter is ahead of the machine. It may be possible to dig small fish reservoirs with this machine, provided it can be done without excessive tracking over the area.

Small (150 hp) Quality Amphibious Ditcher — This machine was retrofitted during the course of the Wertheim project to greatly increase its versatility. It was originally fitted with a 22 inch round rotary ditcher, which can cut straight or curved shallow spur ditches. It also mounts a grader box that allows it to spread and back-blade material into a thin layer, though not with the finesse and precision of the Pisten Bully with its 12-way blade. In addition, the rear attachments can be removed to allow the machine to mount a dump

body for transporting material. This machine can operate on softer ground than the Pisten Bully and cross wider bodies of water than a non-amphibious machine. It is thus nearly as versatile as the Pisten Bully, with the advantage of amphibious tracks.

Kobelco SR-70 LGP Excavator – This is a very useful tool in constructing ponds, but spoil has to be removed by dump body or back-blading, both requiring an additional machine. When the site becomes soft, the machine has a tendency to sink into marsh surface, and to potentially damage root mass of marsh vegetation.

Kobelco SR-70 Amphibious Excavator – This is a useful machine for pond construction. Other equipment is needed in tandem with this excavator to remove the spoils, or to back-blade them. Because this machine can float it can be used under a wide variety of conditions and terrains. It is also easier to transport to the site, capable of being towed over water to the marsh.

It is recommended that SCVC acquire the following machinery:

16-inch Rotary-arm Ditcher – SCVC needs a rotary-arm ditcher. A larger rotary-arm ditcher would be more efficient for larger projects. However, the rotary-arm ditcher is essential for many smaller projects, and this size is probably the most versatile choice. If NYSDEC becomes convinced of the benefits of pond construction to improve fish habitat in its South Shore marshes, then the purchase of a larger cutting head would be in order.

A rotary cutter could be retrofitted onto either one of the SR-70 excavators. Cutters larger than 16 inches require an auxiliary engine and a very large excavator, an expensive and probably not very practical option for Suffolk County conditions.

Amphibious, Long Reach Excavator – The current excavators have standard arm that limit the radius that can be reached without repositioning the machine. Frequently repositioning the machine, particularly when excavating a pond, lowers productivity, and can damage vegetation if not done with great care. A long-reach excavator could excavate a larger area from a single position, and could also load a dump body machine without having that vehicle come immediately alongside the pond. Also, a long reach excavator can, in some cases, place excavated material directly into a receiving area, such

as a ditch adjacent to a pond being dug. A long reach excavator can also work over and around obstacles such as fences and trees more easily than a conventional excavator. It may be possible to retrofit the existing amphibious excavator with a longer arm, but issues such as machine balance may require that an entirely new machine be acquired.

Personnel Transporter – one is needed; two might be preferable.

5.2 Personnel

Marshes are complicated environments, as they exist at the interface of land and water. Manipulation and restoration of a marsh therefore requires skills and knowledge of both land and sea. This means most projects will require the involvement of different fields of expertise, and different kinds of personnel to execute the plans. Prior to the commencement of any restoration project the identification of site-specific goals, objectives and limitations, and the difficulties that may be encountered, must be taken into consideration as part of the planning process. Considerations in planning a restoration project may involve outlining the habitat zones associated with particular tidal wetlands, their vegetation, common fish and wildlife species, habitat functions, and generic impacts to these habitats. Therefore, it may be necessary to consult several different specialists.

5.2.1 Professional Staff

These lists are intended to identify the scope of expertise required by SCVC, and others proposing projects for SCVC to conduct. It should be understood that many of these staffers do not need to be full-time employees; staffing needs may be met by "borrowing" expertise from other government agencies, through advisory groups, by academic contacts or consulting arrangements, or contracting for environmental consultants. It may be that the functions of several titles can be addressed by a single, suitable person.

Natural Resource Manager

The person in this position will be required to oversee the four major phases involved in the process and considerations for restoration projects:

- Planning and Design Phase
- Construction Phase
- Assessment Phase
- Documentation and Communication Phase.

Planning and Design Phase – Overseeing and defining project goals and objectives, the development of specific and quantifiable performance criteria, research of the restoration site, refinement of objectives based on site research, and specific project planning of the project leading to engineering designs and development of a contingency plan for unexpected outcomes. It also should include permit preparation and acquisition.

Construction Phase – involvement in the considerations of effects on natural resources at the site, and adjacent areas; determination of construction staging and timing, so that there is the least impact to existing flora and fauna, and the greatest likelihood of success for any changes in habitat – such as determining the best time to replant; supervision of construction activities and work plan compliance monitors.

Assessment Phase – development of appropriate monitoring plan to meet and test site goals and objectives; implementation of the plan; and identifying needed adjustments to correct the plan during the course of the project, and in the post-project monitoring window.

Documentation and Communication Phase – develop appropriate record-keeping processes and technologies for engineering, construction, and monitoring data, and cost information; turn data into information through accessibility – designate a contact person, and develop a database or central file system; oversee the sharing of results through internet availability, conferences, workshops, public outreach, and other means.

Natural Resource Specialists

The role of a resource specialist is to provide senior technical support to the natural resource manager. The work could in involve:

- inventorying, data collection, and/or resource analysis;
- developing sampling protocol based on technical/scientific principles and practices;
- prescribing solutions to construction and monitoring problems;
- developing narratives and/or statistical reports.

The input from natural resource specialists is extremely important in selecting appropriate goals and objectives for the project, and during design and implementation of monitoring techniques.

Entomologist – An entomologist would be responsible, not only for evaluating mosquito breeding and the effects of projects on mosquito production, but also for the effects of projects on non-target insects, especially aquatic insects. There are a variety of aquatic and other insects that use salt marsh habitats, and it is likely that they would be affected by management measures. It may not be possible to quantitatively measure these effects, but the use of the marsh habitat should at least be documented.

Salt Marsh Ecologist – Salt marsh ecology focuses on the physical dynamics of saltmarshes, to include; sediments, erosion, chemical composition, vegetation structure, ecology of individual organisms, and management and conservation. Therefore, a salt marsh ecologist should be a professional experienced in wetland delineations, have a working knowledge of vegetation identification, soils, and hydrological processes. In addition, the ecologist should have competence in the USACE 1987 Wetlands Delineation Manual, state delineation requirements and experience in permit filing procedures.

Hydrologist – the formation, size, and function of wetlands are controlled by its hydrologic processes. The hydrologic and water quality functions of wetlands – the way wetlands change the quantity or quality of water moving through the marsh – are related to the wetland's physical setting. Hydrologic processes or the hydrologic cycle of wetlands are controlled by tides, storms, precipitation, surface water flow, ground water flow, and evapotranspiration. The relative importance of each of these components differs from wetland to wetland and therefore must be evaluated at each marsh.

A hydrologist will assist the project by performing moderately complex to advanced ecological analysis of surface water resources of the designated restoration site, leading to the planning, execution and summary of scientific and engineering field studies. Also, the hydrologist will be able manage data resources; apply statistical methods and computer programs for the determination of environmental flow needs; and communicate analyses and findings with general and technical audiences.

Complex reworking of the hydrology of a marsh may require advanced computer simulation capabilities. Modern wetting-drying models hold the promise of being able to accurately simulate the effects of changes in existing waterways. These models are only as accurate as the information used to drive them; therefore, any modeling exercise will require intensive collection of appropriate data, including but not limited to hydrographic and other surveys, and local tide and other water flow information. Modeling expertise may be available from Stony Brook University.

Benthic Ecologist – Wetland benthic ecology involves the study of organisms living in and on the marsh substrate, the interactions between them, and impacts on the surrounding environment. The benthos, comprised of the organisms and the substrates together, is an extremely valuable component of the wetland environment. Benthic systems are important to recycling of nutrients, and the burial and storage of organic matter.

The benthic ecologist primarily studies functional relationships among keystone biota in aquatic ecosystems. This research is used to clarify the fundamental trophic linkages between primary producers and consumer, and assesses the role of these trophic interactions in the regulation of energy and biogeochemical nutrient cycles. This is especially important in monitoring the effects that restoration will have on the benthic community. A benthic ecologist must be able to sample, recognize, and analyze benthic communities in a meaningful way that will provide information to other members of the natural resource team.

Botanist – Salt marshes constitute one of the most productive habitats on earth. Typically, salt marshes are broken into three zones, low marsh, high marsh, and open water areas that are generally further defined in terms of salinity gradients and duration of inundation. Each of these zones is extremely critical to ensuring a properly functioning marsh ecosystem; characterizing the existing vegetation patterns and anticipating the impacts of a restoration project is extremely important.

The botanist can assist in the characterization of a marsh; the botanist should be qualified to conduct field studies including but not limited to habitat mapping, rare plant surveys, wetland assessments and delineations, and to prepare related quantitative sampling and statistical analysis. Habitat mapping is an important technique in order to compare pre and post alteration vegetative comparisons in order to evaluate the success of desired results.

Marine Biologist – Tidal wetlands are considered marine resources in New York State, and evaluating and ensuring that management actions sustain and enhance marine biota is a critical aspect of these actions. Certain fish species reside in salt marsh waters for most of their life cycle, such as the mummichog (*Fundulus heteroclitus*), striped killifish (*F. majalis*), and sheepshead minnow (*Cyprinojon variegates*). Other species of fish depend on the salt marsh habitat, associated tide creeks, and adjacent mud flats for nursery areas, such as winter flounder (*Pleuronectes americanus*), Atlantic silverside (*Menidia menidia*), sand lance

(*Ammodytes americanus*), and striped bass (*Morone saxatilis*). Several diadromous fish inhabit wetlands, such as American eel (*Anguilla rostrata*), alewife (*Alosa pseudoharengus*) and menhaden (*Brevoortia tyrannus*). Invertebrate macrofauna, such as ribbed mussels (*Geukensia demissa*), fiddler crabs (*Uca spp*.), salt marsh snails (*Melampus didentatus)*, and blue crabs (*Callinectes sapidus*), may be important to document. Therefore, prior to proceeding with any restoration project, the effects of the project on the marine community must be determined.

Knowledge of the different habitats needed throughout different life stages of fish and key invertebrates will help in deciding where ponds and tidal creeks should be placed in order to enhance a desirable marine habitat.

Ornithologist – Many bird guilds utilize salt marshes throughout all or part of their life history. Many species rely on the marsh for nesting and rearing their young, such as the marsh wren (*Cistothorus palustris*), sharp-tailed sparrow (*Ammodramus caudacutus*), black-crowned night heron (*Nycticorax nycticorax*), Canada goose (*Branta canadensis*), American black duck (*Anas rubripes*), red-winged blackbird (*Agelaius phoeniceus*), and sometimes clapper rail (*Rallus longirostris*), and willet (*Catoprophorus semipalmatus*). Others depend on the marsh for food, feeding on small fish, invertebrates, insects, and vegetation, such as the green heron (*Butorides striatus*), great egret (*Casmerodius albus*), snowy egret (*Egretta thula*), glossy ibis (*Plegadis falcinellus*), tree swallow (*Tachycineta bicolor*), and terns (*Sterna spp*.). Also the northern harrier (or marsh hawk) (*Circus cyaneus*) and short-eared owl (*Asio flammeus*) are known to hunt for rodents on the marsh. Immature bald eagles (*Haliaeetus leucocephalus*) sometimes overwinter on Long Island marshes, and ospreys (*Pandion haliaetus carolinensis*) build impressive nests overlooking salt marshes, often on poles provided for this very reason. Therefore, it is extremely critical that any impact to the marsh be analyzed for the effect it will have on its avian community.

The ornithologist will help identify the bird species at risk and the limiting factors involved with restoration activities. This expertise is critical to help evaluate management approaches and documenting recovery.

Other Technical Staff

GIS Programmer/Analyst – Geographic Information Systems (GIS) is a technology used to analyze data from a geographic perspective. A GIS interactive map can provide geographic information for analysis, advanced data compilation, and field data collection. This is extremely useful in the design and implementation phase of a restoration project. In addition, through the use of historical aerial photography and satellite imagery it is possible to perform a long-term analysis of changes in wetland areas and evaluate any patterns or trends that may be observed.

GIS programmer/analyst responsibilities may include writing, testing, and debugging customized GIS applications for maintaining and accessing site data, conducting spatial analyses, and developing GIS applications and map products for various users to support implementation of site restoration. Other duties may include coordinating habitat mapping applications and effectively communicating with colleagues, staff, other agencies, organizations, and the public.

Engineers (Environmental) – In developing a plan for the restoration project, the engineer is a valuable asset to the successful completion of this task. An engineer can assist in determining the level of physical effort needed, technological requirements, cost estimates, and construction scheduling (such as amount of laborers, machine operators, and equipment requirements).

The environmental engineer uses the principles of biology and chemistry to develop solutions to environmental situations. An engineer should be consulted on many of the purposed actions in this BMP (i.e., culvert replacement, pond construction, tidal creek design). The engineer can assist in the design; implementation, analysis of the scientific data collected, and quality control

checks. An important engineering determination is an estimate of the amount of spoil that may be generated by any given action, which will assist in the decision of spoil control.

Surveyors – Delineating wetland boundaries is an important part of any restoration project and may be necessary when applying for federal and state permits. In this case a surveyor, preferably one who is a Certified Wetland Delineator, will be needed to accurately map the wetland boundaries. In addition, accurate post-construction mapping may be required in many instances.

5.2.2 Project Implementation Staff

This staff is likely to be agency or other full-time staff. Although BMP implementation is not likely to be a full-time, year-round job, actual construction is often intensive and will require greater commitments of time than most of the other positions described above.

Site Supervisors – These personnel are responsible for overseeing and coordination of site specific work. They are also responsible for monitoring for impacts to the marsh and ensuring that heavy equipment does not do irreversible damage to vegetation. Biological training is useful and important.

Construction Foreman – The construction foreman is responsible for coordinating with Site Supervisors as to where and what work should be performed. The Foreman determines the division of labor among operators and laborers, and maintains good working conditions at the site.

Machine Operators – Several of the machines require a driver and an equipment operator, such as the Pisten Bully and the Quality Ditcher. All operators should be experienced in operation machinery for marsh restoration/maintenance. A trainee program for junior staff would be useful.

Laborers – Construction laborers perform a wide range of physically demanding tasks involving loading equipment onto machinery, performing minor excavating

tasks on the marsh, digging small sill channels, and removing clogs from ditches or tidal channels by hand.

Appendix 2 - Pesticide Labeling Requirements

Section 1 – Introduction

FIFRA provides for federal control of the distribution, sale and use of pesticides. All label language must be approved by USEPA prior to a pesticide being sold or distributed in the United States. The pesticide label is the primary document for conveying general and technical information from regulatory agencies and pesticide manufacturers to mosquito control agencies, the agricultural community, the commercial service industry, and the general public. It is the one source where scientific review, regulatory oversight, and public policy are interwoven to achieve a common objective: to clearly and precisely convey information on handling, storing, applying, and disposing of pesticides in a manner conducive to good health and environmental stewardship (Whitford et al., 2001).

Pesticides are developed by the manufacturer, registered with USEPA, and sold to the public with the assumption that users read, understand, and follow instructions found on the product label. Specific information on use, personal protective equipment, environmental precautions, and storage and disposal are found on the pesticide label. The purpose of the label is to provide clear directions to allow maximum product benefit while minimizing risks to human health and the environment. All research, testing, and regulatory processes ultimately are reflected through the language on the label (NYSDEC, 2003a).

Every pesticide label includes the statement, "It is a violation of federal law to use this product in a manner inconsistent with its labeling." This language obliges the purchaser or user of any pesticide to assume all legal responsibilities for the use of the product. Further, courts of law and regulators recognize the pesticide label is a binding contract that requires the person using the product to do as exactly as directed. Terms such as must, shall, do not, and shall not mean that the user is responsible for specific actions when applying or handling the given product. Any departure from such directions is, in the eyes of the law, an illegal use of the pesticide (NYC DEIS, 2001).

"Use" means more than just the application of the pesticide. Federal and state regulations define pesticide use to include handling, mixing, loading, storage, transportation, and disposal, as well as human and environmental exposure. This all-encompassing

definition covers every activity that involves a pesticide—from purchase to container disposal. Many statements on the label result from rigorous scientific investigation and governmental regulatory decisions. Pesticide users should read, understand, and follow pesticide label directions to ensure effective pest control, personal safety, environmental protection and legal compliance (Whitford et al., 2001).

Every pesticide product must bear a label that contains the information specified in FIFRA and the regulations in 40 CFR 156.10. The contents of the label must clearly and prominently show the following (information presented here through Section 4.4 is taken from the federal regulations):

- Name, brand, and trademark under which the product is sold
- Name and address of the producer, registrant, or person for whom the product was produced
- Product Registration Number
- Producing Establishment Number – referring to the final establishment at which the product was produced or finished
- Net Contents, as set forth below:
    - The net weight or measure of content shall be exclusive of wrappers or other materials and shall be the average content unless explicitly stated as a minimum quantity.
    - If the pesticide is a liquid, the net content statement shall be in terms of liquid measure at 68 degrees Fahrenheit (°F) (20 degrees Celsius [°C]) and shall be expressed in conventional American units such as fluid ounces, pints, quarts, or gallons.
    - If the pesticide is a solid or semisolid, viscous or pressurized, or is a mixture of liquid and solid, the net content statement shall be in terms or weight expressed as pounds and ounces.

- In all cases, net content shall be stated in terms of the largest suitable units, i.e. “1 pound 10 ounces” rather than “26 ounces.”

- In addition to the required units specified, the net content may be expressed in metric units.

- Variation above minimum content or around an average is permissible only to the extent that it represents deviation unavoidable in good manufacturing practice. Variation below a stated minimum is not permitted. In no case shall the average content of the packages in a shipment fall below the stated average content.

- Warning or precautionary statements. Every pesticide product label must bear on the front panel the statement “Keep Out Of Reach Of Children.” However, human hazard signals and precautionary statements will vary according to the product’s toxicity to humans, as discussed under “Toxicity Categories.”

- Ingredient Statement, which must contain the name and percentage by weight of each active ingredient, the total percentage by weight of all inert ingredients, and , if the pesticide contains arsenic in any form, a statement of the percentages of total and water-soluble arsenic calculated as elemental arsenic. Accepted common names are to be used followed by chemical name unless the common name is widely known. In cases where the pesticide formulation changes considerably over time (degradation), the following statement must be written on the label: “Not for sale or use after [date].” The product must meet all requirements on the label through that date. Inert ingredients may need to be listed if they pose a hazard to public health or the environment.

- Use Classification, indicating whether the product is for general use, restricted use, or both. If it is a restricted use product, specific directions must follow. Other information may be required if its use is restricted to certain applicators.

- Directions for use, which must be easily read and understandable by the average person who will use them. They may appear anywhere on the label providing they may be easily read. Directions may be omitted if:
    - The product is only to be used in manufacturing.
    - It will not come into the hands of the public
    - It has data sheets specifying products involved
    - It is determined that directions are not necessary to prevent unreasonable adverse effects on humans and the environment
    - It is only to be used by a physician
    - It is a drug regulated under the Federal Food, Drug, and Cosmetic Act (FFDCA)
    - It will only be used by formulators of pesticide

Section 2 Safety Information

Child hazard warning. The front panel of every pesticide product label must bear the statement, "Keep Out Of Reach Of Children." USEPA may waive this requirement only in cases where the likelihood of contact with children is extremely remote, or when the product is approved for use on children.

A **signal word** must appear prominently on the front of the pesticide container, providing, in essence, a one-word summary of the product's potential toxicity to humans. The three signal words, in decreasing order of toxicity, are DANGER (highly toxic), WARNING (moderately toxic), and CAUTION (slightly toxic).

A signal word is assigned on the basis of laboratory tests conducted with that particular product. Data are compiled from animal studies on exposure through ingestion, inhalation, and dermal (skin and eye) absorption. The route of exposure which shows the highest human toxicity potential determines the signal word assigned to the label. For example, if laboratory test results indicate product XYZ to be moderately toxic if ingested, highly toxic if inhaled, and slightly toxic if absorbed through the skin or eyes, the signal word would be danger based on inhalation studies, and would be DANGER.

Hazards to humans and domestic animals. Precautionary statements indicating specific hazards, routes of exposure, and precautions to be taken to avoid human and animal injury are required on the label. For example: "Harmful if swallowed, inhaled, or absorbed through the skin." Precautionary warnings might include the language, "Do not breathe vapors or spray mist;" "Avoid contact with eyes, skin or clothing;" or "Handle concentrate in a ventilated area."

The **protective clothing and equipment statement** directs the applicator to reduce the potential for exposure by using protective clothing or equipment. Most pesticide labels contain very specific instructions concerning the type of clothing that must be worn during the handling and mixing processes.

Potential routes of exposure determine the types of protective clothing designated on the label. Generally, a long-sleeved shirt, long pants, and waterproof footwear are the

minimum requirements. The label will state whether specific items such as respirators and chemical-resistant gloves, aprons, goggles, and boots are needed. Common label language includes "Wear full face shield, rubber gloves, apron, and waterproof footwear when pouring concentrate or when exposure to concentrate is possible," and "Eye protection and chemically resistant gloves and footwear, a long-sleeved shirt, and long-legged pants or coveralls are recommended."

The **Statement of practical treatment** (first aid) provides valuable information to persons at the scene of a pesticide poisoning. Some examples: "In case of contact with skin, wash immediately with plenty of soap and water;" "If swallowed, call a physician or poison control center immediately;" "Immediately wash eyes with water for at least 15 minutes and get medical attention;" "After first aid is given, take victim to clinic or hospital;" or, "If inhaled, remove victim to fresh air."

The statement of practical treatment informs physicians and emergency responders of appropriate medical procedures for poisoning victims. For example, the statement might indicate to a physician: "There is no specific antidote;" "If the product is ingested, induce emesis or stomach lavage;" or "The use of an aqueous slurry of activated charcoal may be considered." Products labeled DANGER also bear a toll-free telephone number that physicians may use for further treatment advice. Emergency telephone numbers are provided on the Material Safety Data Sheet (MSDS). The pesticide distributor or manufacturer should be contacted for the MSDS.

Section 3 Environmental Information

Environmental hazard statements are required to state the nature of potential hazards and appropriate precautions to avoid accident, injury, or damage if the product presents risks to non-target organisms or the environment. Potential hazards are determined by a series of tests that evaluate a pesticide's toxicity to wildlife such as mammals, fish, birds, aquatic invertebrates, and pollinating insects. Statements might include label language such as, "This product is highly toxic to bees," or "This product is highly toxic to fish," or "…toxic to aquatic invertebrates." To reduce the risks, the label may direct measures such as, "Do not allow drift to contact nontarget plants," or "Do not apply directly to water or wetlands."

If the pesticide has the potential to harm an endangered or threatened species or its habitat, statements will indicate where not to apply the pesticide or refer the user to an endangered species bulletin for further information. For example, the label might read "Use of this product in a manner inconsistent with the Pesticide Use Bulletin for Protection of Endangered Species is a violation of federal law," "Restrictions for the protection of endangered species apply to this product," or "If restrictions apply to the area in which this product is to be used, you must obtain the Pesticide Use Bulletin for Protection of Endangered Species for that county."

Statements on environmental impact may indicate that the product "…may travel through soil and can enter ground water," or "…has been found in ground water." The label instructions will tell how to reduce the impact on the environment: "This product may not be mixed, loaded, or used within 50 feet of all wells, including abandoned wells, drainage wells, and sink holes," or "This product has been shown to leach under certain conditions. Do not apply to sand and loamy sand soils where the water table (ground water) is close to the surface."

Section 4 Product Information

The **brand (trade) name** under which a pesticide product is sold always appears on the front panel and often is the most conspicuous part of the label.

The **name and address of the producer, registrant, or person for whom the product was produced** must be shown on the label. If the registrant's name appears on the label and the registrant is not the producer, it must be qualified by appropriate wording such as "Packed for…" "Distributed by…" or "Sold by…."

The **net weight or volume of the contents** of the formulated pesticide product is displayed prominently on the label or stamped on the container.

The product registration number appears on the label, preceded by the phrase "EPA Registration No." or "EPA Reg. No." The registration number identifies a specific pesticide product and signifies that federal registration requirements have been met. At a minimum, registration numbers consist of two sets of digits: e.g., 491-005. The first set of digits identifies the registrant. The second set represents the specific registration issued to the company by USEPA. Together, these numbers clearly identify the product.

The **establishment number** is preceded by the phrase "EPA Est." USEPA requires pesticide production sites to be registered with USEPA. A pesticide-producing establishment is assigned a USEPA establishment number that clearly identifies that location. All pesticides produced at that location must bear its USEPA establishment number on the label or container. Farm service centers that repackage bulk pesticides must be registered as pesticide-producing establishments and, as with all pesticide producers, must keep records of their pesticide production and file annual production reports.

The **ingredient statement** normally is found on the front panel of the label. It identifies the name and percentage of a pesticide product that affects the target pest. Chemical names often are complex; for example, *2-chloro-4-ethylamino-6-isopropylamino-s-triazine* is the active ingredient in the product *AAtrex*. To aid communication, USEPA-approved common names may be substituted for chemical names.

Inert ingredients allow active ingredients to be formulated into many different products. As part of the formulation, they determine a product's handling properties and influence toxicity, release rates, residual activity, persistence, and methods of application. Also, there are no pest controlling claims for inert ingredients and, because product formulations are confidential, the total percent by weight of inert ingredients usually is the only information about inert ingredients found on the label.

The **formulation** of the product often appears on the front panel of the label, either near the brand name or in the general information section. Pesticides may be formulated into many products; currently, in the US, some 450 active ingredients are formulated into 25,000 different products. Information about the type of product formulation—granular, liquid flowable, dry flowable, microencapsulated, emulsifiable concentrate, etc—provides insight about application equipment, handling properties, and performance characteristics.

General-use versus restricted-use classification. USEPA may classify a certain pesticide product for restricted use due to the complexity of the designated use, concerns about environmental safety, or potential human toxicities. A restricted-use product may be bought and used only by a certified applicator or persons under the direct supervision of a certified applicator. A restricted-use statement appears conspicuously at the top of the front panel of the label to make this classification obvious. All restricted-use pesticides are identified by the following language: "For retail sale to and use only by certified applicators or persons under their direct supervision, and only for those uses covered by the certified applicator's certification."

Pesticides that remain unclassified are referred to as general-use pesticides and may be purchased by the public. Most pesticides used by homeowners are general-use products. However, there is no positive statement on labels approving the chemical for homeowner use. Rather, it is the absence of the restricted use statement that allows for general use. Nothing that can be interpreted as a "general use statement" ever will appear on the product label.

The **physical and chemical hazard statements** identify a given pesticide's flammability or explosiveness. These statements show specific hazards and state conditions to be avoided. For example: "Extremely Flammable;" "Contents Under Pressure;" "Keep away from fire, sparks, and heated surfaces;" "Do not puncture or incinerate containers;" "Exposure to temperatures above 130º F cause bursting."

The **warranty** information is the manufacturer's assurance that the product conforms to the chemical description on the label and that it is fit for labeled purposes if used according to directions under normal conditions. The warranty does not extend to any use of the product contrary to label instructions, nor does it apply under abnormal conditions such as drought, tornadoes, hurricanes, or excessive rainfall.

Section 5 Use Information

Misuse statements contain language such as, "It is a violation of federal law to use this product inconsistent with its labeling."

Storage and transportation statements may include the following: "Store at temperatures above 32º F;" "Do not contaminate feed, foodstuffs or drinking water;" "Do not store next to feed or food, or transport in or on vehicles containing foodstuffs or feed;" or "For help with any spill, leak fire or exposure involving this material, call Chem Trek (800-424-9300)." Directions for use often comprise the bulk of a pesticide label. They must be adequate to protect the public from fraud and personal injury and to prevent unreasonable adverse effects on the environment. The instructions must provide guidance to the user on the pests controlled, sites of application, compatibility with other pesticides, mixing or dilution rates, application rates, equipment needed for application, timing and frequency of applications, harvest intervals, and general information for successful results.

Directions for use may appear on any portion of the label. Because of the detail required for specific applications, use directions for common sites, pests, and applications may be grouped together under a general heading. Information specific to individual uses may be addressed under specific headings.

Container rinsing and disposal statements list proper procedures for handling pesticide containers and disposing of unused products. Federal, state, and local regulations often must be consulted to determine how to dispose of unused pesticide concentrates or diluted mixtures. Container disposal statements could read "Triple rinse (or equivalent);" "Do not reuse container;" "Offer for recycling or reconditioning;" "Puncture and dispose of in a sanitary landfill;" "Disposal by other procedures allowed by state and local authorities;" "Improper disposal of excess pesticides, spray mixture, or rinsate is a violation of federal law;" "If these wastes cannot be disposed of by use according to label instructions, contact your state pesticide or environmental control agency, or the hazardous waste representative at the nearest EPA regional office for guidance." While

numerous pesticide labels still state that properly rinsed containers may be burned, almost every state has clean air laws that prohibit such disposal.

Appendix 3 – Comparison of Suffolk County Vector Control to Other Regional Mosquito Control Agencies

Suffolk County Vector Control & Wetlands Management Long Term Plan & Environmental Impact Statement

Task 4 Suffolk County Vector Control Comparison With Other Northeast Operations

Prepared for:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

Bs	*Bacillus sphaericus*
Bti	*Bacillus thuringiensis israelensis*
CAES	Connecticut Agricultural Experiment Station
CDC	Centers for Disease Control
CDEP	Connecticut Department of Environmental Protection
CDPH	Connecticut Department of Public Health
CO_2	Carbon dioxide
DFTA	Department for the Aging
DOHMH	Department of Health and Mental Hygiene
DPW	Department of Public Works
EEE	Eastern Equine Encephalitis
GIS	Geographical Information System
GPS	Global Positioning System
IMM	Integrated Mosquito Management
MMD	Mass Medium Diameter
NCDH	Nassau County Department of Health
NCDPW	Nassau County Department of Public Works
NJAES	New Jersey Agricultural Experiment Station
NJDEP	New Jersey Department of Environmental Protection
NJSMCC	New Jersey State Mosquito Control Commission
NYPD	New York Police Department
NYSDEC	New York State Department of Environmental Conservation
OMWM	Open Marsh Water Management
PCR	Polymerase Chain Reaction
RAMP	Rapid Analyte Measurement Platform
SCDHS	Suffolk County Department of Health Services
SCDPW	Suffolk County Department of Public Works
SCVC	Suffolk County Vector Control
UConn	University of Connecticut
ULV	Ultra-Low Volume
WCDH	Westchester County Department of Health
WNV	West Nile virus

1. Introduction

The purpose of this report is to provide a comparison between the operations of the Suffolk County Department of Public Works (SCDPW), Division of Vector Control and other mosquito control operations in the immediate northeast region. In order to accomplish this, site visits and interviews were conducted with the operating agencies in Nassau County and Westchester County as well as the Suffolk County agency itself. Additional information regarding the operations of mosquito control agencies in New Jersey was provided via the input of Dr. Wayne J. Crans of the New Jersey Agricultural Experiment Station (NJAES) at Rutgers University. Information on the Connecticut State program was provided by Roger Wolfe, Mosquito Management Coordinator for the Connecticut Department of Environmental Protection (CDEP).

New Jersey is regarded as a model for mosquito control because of Title 26 enabling legislation designed by John B. Smith at the turn of the last century. Smith, a biologist at Rutgers University who was also trained as a lawyer, drew up the set of laws to assure that mosquito control decisions are based on science. New Jersey is the only state where mosquito control is mandated at the county level with university input on an annual basis. This effectively links the applied aspects of mosquito control with current advances in science to assure that environmental issues are properly addressed.

The NJAES is mandated under Title 26 Chapters 3 & 9 of the New Jersey Health Statutes to review the Plans and Estimates of New Jersey's 21 County Mosquito Control Programs on an annual basis and provide written comments to individual County Boards of Chosen Freeholders by December 1 of each year. To facilitate the process, guidelines have been developed that set standards for mosquito control operations to promote valid comparisons of the mosquito control efforts in the state.

NJAES looks for five necessary components in mosquito control work plans:

1. Surveillance

2. Source Reduction

3. Chemical Control

4. Biological Control

5. Education.

The evaluations in this report are based on these components. This report outlines the criteria NJAES uses to evaluate New Jersey mosquito control programs and then applies those criteria to the New York programs of Nassau and Westchester Counties, and New York City, selected mosquito control programs in the state of New Jersey, and the Connecticut State program. Additional pertinent criteria are also reviewed. The evaluations are also used to compare the jurisdictions to operations in Suffolk County.

2. Components of a Responsible Mosquito Control Program

2.1. Surveillance Component

Mosquito management must begin with a surveillance initiative to document pest and vector species, which provides justifications regarding control decisions. Although more than 60 mosquito species are native to the northeastern United States, approximately 15 species function as serious threats to human health and well being. A number of mosquitoes in the northeast do not feed on human blood; these targeted by species are classified biological curiosities in terms of mosquito management, and should not be targeted by mosquito control operations. Others have extremely limited flight ranges so that they rarely bite humans even though they do host seek for blood. Thus, species-specific records need to be developed prior to considering control of any kind. Records should also be maintained that delineate the composition of mosquito populations before and after management to determine the effectiveness of control operations, and to justify their costs and potential environmental impacts. Surveillance programs should have components addressing larvae, adults, and mosquito-borne pathogens. To accomplish these goals, qualified staff with ongoing training must be in place, both to implement surveillance programs and also to evaluate the surveillance data. Thus, mosquito control is more than a profession that goes well beyond pest control, but is a professional undertaking. Resource allocations must include laboratory space equipped with up to date scientific equipment, to support surveillance that will determine the scope of control aspects of the program.

2.2. Source Reduction Component

Source reduction (e.g. the alteration or elimination of larval habitat) is the most effective method for long-term relief from mosquito infestation. A responsible source reduction effort should be in place before chemicals of any kind are considered to reduce mosquito populations. Source reduction can be as simple as the removal of used tires and the cleaning of rain gutters by property owners. Source reduction can also entail extensive regional water management projects to eliminate mosquito-breeding habitats. Source reduction activities should be undertaken to eliminate or substantially reduce the need for applications of insecticides in habitats that chronically produce mosquitoes. When properly designed, source reduction initiatives maintain,

rather than eliminate wetlands habitats and enhance them for wildlife utilization. Mosquito control is often blamed for having a negative impact on the environment, but properly designed source reduction activities can enhance wetland features.

Source reduction activities are generally divided into Sanitation, Freshwater Wetlands Management, and Saltmarsh Water Management. Source reduction practiced by responsible mosquito control agencies includes a broad scope of activities that range from simple sanitation to major water management programs. Wetlands management generally requires permits from county, state, or federal governments. As a result, qualified staff are required to recognize problems, design solutions, address regulatory requirements, and implement meaningful source reduction projects.

2.3. Chemical Control Component

When surveillance has documented a problem, and sanitation or water management do not provide feasible solutions, NJAES supports the use of chemicals to control immature and/or adult mosquito populations. The chemicals used by mosquito control agencies must comply with state and federal regulations and be applied according to label restrictions. In New Jersey, recommendations for pesticides used in mosquito control are provided annually by researchers at NJAES, and the recommendations are available for any mosquito control agency on request. All pesticide applicators and operators must be licensed by the state and receive ongoing training on a yearly basis. Larviciding (applying chemicals to kill the immature stages of mosquitoes by ground or aerial treatments) is more effective than focusing on adults because the immature stages can be targeted at the breeding habitat before populations have had a chance to disperse. Applications of larvicides impact less acreage than adulticiding operations because treatments are made to relatively small areas where larvae are concentrated as opposed to wider regions after adult populations have dispersed. Biorational larvicides including *Bacillus thuringiensis israelensis* and *Bacillus sphaericus* (bacterial larvicides) and methoprene (an insect growth regulator) should be used whenever possible, although temephos (an organophosphate) and petroleum oils are feasible in many situations. Adulticiding is the use of chemicals to reduce adult mosquitoes by ground or aerial applications. Adulticides are commonly applied as an

Ultra-Low Volume (ULV) spray using small amounts of active ingredient dispensed through equipment that must be properly maintained and calibrated.

2.4. Biological Control Component

Biological control is the utilization and/or manipulation of natural agents to aid in the control of pest and vector species. Biological control efforts support the concept of integrated pest management and are advantageous because they are generally host-specific for mosquito control with limited impacts on non-target species. As a result, biological control practices often include creating or enhancing habitat that supports organisms that impact mosquito populations. Although many biological control initiatives for mosquito control are still in the experimental stages of development, NJAES believes that every mosquito control program should be exploring available options. Predacious fish have been shown to effectively reduce mosquito larvae in many mosquito breeding habitats and represent an effective biological control agent for use in virtually all mosquito control programs, regardless of size or budget. Predacious fish, typically *Gambusia* species, can be reared and stocked in mosquito breeding habitats as an alternative to using larvicides. When native fish populations are known to exist, well designed water management projects enhance biological control by creating habitat that encourages native fish to function better in terms of natural predation. Although individual county mosquito control agencies can raise and release their own fish, state sponsored regional programs are encouraged to provide predator fish species for field release. In 1990, the State of New Jersey established a state-wide mosquitofish program with a specific protocol for distribution and use. While originally designed for *Gambusia affinis*, the program now offers other fish species for mosquito control including the fathead minnow, the freshwater killifish, and two species of native sunfish.

2.5. Educational Component

Mosquito control agencies should have programs of public education and continuing education as ongoing activities of their work plans. Public education must be initiated by the mosquito control agency to teach mosquito biology to the public and encourage citizens to utilize prevention techniques. Examples include: bullet list fact sheets and brochures, classroom

lectures at schools, slide shows, films and videos on mosquitoes and their control and exhibits at state and county fairs. Responsible mosquito control agencies interact with civic leaders, politicians, and professionals on a regular basis to eliminate crisis management, which typically relies too heavily on pesticides. Properly designed public education programs reduce homeowner pesticide applications and encourage support for organized mosquito control.

Continuing education encompasses programs for operational workers to instill or refresh knowledge related to practical mosquito control procedures. All too often, the importance of continuing education is overlooked and under utilized in job training at mosquito control facilities. Mosquito control is a profession that is based on science and the latest advances in mosquito control technology cannot be obtained without a proper educational component. Examples of continuing education for mosquito control workers include: bullet list pesticide training programs, mosquito control short courses, and "Right to Know" training for hazardous substances. The most important form of continuing education for the professional staff that direct the surveillance, water management and administrative components of the operation is attendance at state, regional and national mosquito control conferences. Interaction with peers at scientific conferences promotes professionalism and ongoing training that cannot be obtained in any other venue.

3. Mosquito Control Programs in the Northeast

3.1. Westchester County, New York

The Westchester program for mosquito control is located in the Westchester County Department of Health (WCDH), Division of Environmental Health Services, and is operated out of the District Office in New Rochelle, NY. Mosquito control activities are conducted by seven fulltime workers, two conducting surveillance and five for control. During the summer months, as many as 40 additional staff are made available from the Health Department to assist with mosquito related activities. Budgetary figures were not available at the time of the interview but funding has been relatively constant over the past three to four years. Westchester County discontinued an earlier program in 1984 that was run out of Fordham University and directed toward ticks as well as mosquitoes. The current program was restructured in 2000 as a direct result of the 1999 outbreak of West Nile virus (WNV) in the New York metropolitan area. The Westchester County program is evolving but operates as a WNV control program and, as a result, lacks a number of components necessary for comprehensive mosquito control.

3.1.1. Surveillance Component

The surveillance component of the Westchester program is excellent but is limited to monitoring the mosquito vectors of WNV. Adult surveillance consists of operating Center for Disease Control (CDC) traps baited with carbon dioxide (CO_2) three times each week together with gravid traps baited with an oviposition attractant at 10 locations in the county, from mid-May to mid-October. The specimens are identified to species, pooled under cold chain conditions, and sent to the New York State Department of Health laboratories in Albany for virus tests. The information is ultimately entered into the Health Information Network and expertly analyzed, in house, to compile meaningful species lists, infection rates and vector population trends. As with most small mosquito control programs, the surveillance data are compiled after the fact and are used to document overall seasonal trends. As a result, very little information is provided by this surveillance effort to drive control aspects of the program and no system is in place to generate

data on the day-to-day fluctuations in mosquito population levels that are needed to make responsible control decisions.

Larval surveillance in the Westchester program includes a comprehensive catch basin evaluation program, beginning in March and April that is focused in the most densely populated areas of the county. The program has compiled a data set of overall larval habitats in their county, but inspections of floodwater and permanent water habitats are not an ongoing activity.

The personnel that coordinate surveillance in Westchester County are well trained biologists and highly qualified to run the program. This means staff is in place if the County decides to expand its program beyond WNV surveillance to a more comprehensive approach to mosquito control.

3.1.2. Source Reduction Component

The source reduction component of the Westchester program consists of monitoring and treating catch basins to control *Culex* mosquitoes and is coordinated by WCDH. Westchester County is not aggressive in efforts to gain access to private property for either inspection or control activities. The large pieces of equipment normally associated with mosquito control activities are not available to establish a water management component at the present time. Teams of inspectors sampling larval habitats on a county-wide basis are not a part of this program. Ditch maintenance, while feasible, is also not an activity in the current work plan. The existing program is directed primarily toward WNV transmission and its amplification vectors. Adding monitoring and control of likely bridge vectors to this program would require additional staff, additional equipment, and a completely revised work plan.

3.1.3. Chemical Control Component

Larviciding catch basins is the only mosquito control measure conducted by the county. Of the approximately 65,000 catch basins located on public land in the county, 55,000 are treated with ALTOSID® XR Briquettes, which are designed to provide up to 150 days of larval control in water. Treatments are done from approximately mid May to the end of June. During that time approximately 10 certified applicators work every week, each treating an average of 200 catch basins per day. The treatment is accomplished with a two-man crew, one being the driver who is

responsible for marking maps with treatment sites, and the second being the applicator. Once treated, the catch basin is marked with a single orange spot on the grate. Catch basins that cannot be treated because they are full of sediment, and therefore do not retain water, are marked with a double orange spot. There are approximately 5,000 additional catch basins on county roads that are treated by county Department of Public Works (DPW) personnel.

There are an estimated 45,000 additional catch basins located on private properties such as malls, housing developments and office complexes that are not treated because the treatment permit issued by the New York State Department of Environmental Conservation (NYSDEC) Region 3 only allows the treatment of catch basins on public land.

In the event of a health emergency, WCDH does have the authority to treat mosquito breeding sites on private property if the proper permits are obtained.

WCDH does not have any equipment to perform adult mosquito control. Adulticide operations in the past were accomplished via a contractual arrangement with Clarke Environmental Mosquito Control from Roselle, IL. Future adulticide applications, if necessary, would be performed under a similar contractual arrangement.

3.1.4. Biological Control Component

The Westchester program for mosquito control does not have a biological control component. Their mosquito control efforts rely on pesticides for larval control with a strong public education component.

3.1.5. Educational Component

The Westchester mosquito control program has an excellent public education component. This is a direct result of having qualified personnel, and the public health educators through WCDH. The Westchester staff maintains a website, develops public service announcements, participates in school visitations, and maintains a presence at health fairs. Funds are limited for ongoing professional education, particularly for allowing staff personnel to attend conferences beyond the regional level.

3.2. Nassau County, New York

Mosquito control in Nassau County has a long, rich history, beginning in 1915. Mosquito control activities were established under a commission in 1929 and were placed within the Department of Public Works in 1948. The current program for mosquito control is a cooperative effort between the Nassau County Department of Public Works (NCDPW) and the Nassau County Department of Health (NCDH). This combination was implemented in 1996, and integrates Integrated Mosquito Management (IMM) technology with public health science. Sanitarians from the health department provide a cadre of trained biologists to assure that mosquito control is based on science. Inspectors, vehicles, and large mosquito control equipment are housed within the NCDPW portion of the operation.

The Nassau County mosquito control program has 20 full time employees and an annual budget of approximately $1,200,000. Some of the personnel are sanitarians employed by the NCDH and some are mosquito inspectors employed by the NCDPW exclusively for mosquito control. All 20 employees are cross-trained to conduct surveillance, larviciding, and species identification. All personnel are tested for mosquito control and are deputized by the health commissioner to perform mosquito control enforcement activities. The county's relatively high population density results in an emphasis on urban mosquito control. The county, however, has significant salt marsh habitat along its coast that must be regularly monitored for floodwater salt marsh mosquito broods. The urbanization of the upland areas of the county limits fresh floodwater species from occurring in large numbers. Urbanization promotes high *Culex* production, with catch basins and water retention facilities, such as recharge basins, generating the largest populations.

3.2.1. Surveillance Component

The Nassau County surveillance program includes larval surveillance, adult surveillance, and virus surveillance components. Urbanization in Nassau has eliminated many mosquito species through habitat loss. As a result, species-specific identification is relatively simple to implement for responsible mosquito control, requiring relatively little laboratory space for taxonomic efforts.

Much of Nassau County's surveillance effort is towards breeding habitat that is surrounded by water that must be surveyed by boat. Mosquito inspectors must be able to distinguish non-breeding marsh that is inundated regularly by tide from high marsh habitat that is capable of producing regular broods of salt marsh mosquitoes. Because of the narrow window between egg hatch and adult emergence in salt marshes, larval inspections focus on detection of mosquitoes in very early instars. Virtually all mosquito species produced on tidal salt marshes function as major biting pests. Under these conditions, inspectors can determine the need for control without having to identify most collections to species. This allows the county to field-train their inspectors without insisting on a complete range of species identification skills.

Culex mosquitoes are the primary focus for mosquito control in upland areas of Nassau County. Approximately 70,000 catch basins and 600 retention basins are monitored on a regular basis. *Culex* larvae are unique enough to be recognized in the dipper. As a result, *Culex* from stagnant water collections can be controlled on the basis of presence without having to wait for species confirmation from the laboratory.

For adult mosquitoes, the Nassau County program operates seven New Jersey light traps from May to October. The data are used primarily to estimate the size of their mosquito populations, as collections are usually not identified to species. Nassau County runs an intense adult surveillance effort to monitor the mosquito vectors of WNV. CDC light traps and gravid traps are operated regularly at more than 42 collection sites representing 2.5-mile sampling intervals within the county. The specimens are identified to species and pooled for virus tests by NCDH sanitarians. The samples are then sent to Albany with a seven-day turn around time for virus results. Results from the WNV surveillance effort are used to develop a summary of female mosquitoes trapped by species each year. Nassau has an extensive crow surveillance program operated out of the NCDH that is used by mosquito control personnel to pinpoint areas of WNV activity. This surveillance effort is as comprehensive as any in the nation.

The Nassau County program responds to citizen complaints and uses the information as an important aspect of its surveillance component. All complaints are logged and assigned to an inspector for follow-up action. Once inspections are completed, property owners are advised of the action and provided with mosquito literature whenever possible.

The surveillance activities of the Nassau County program provide the following triggers that are used to justify control:

1. Mosquito trap counts
2. WNV virus isolations from mosquitoes
3. Dead crow reports
4. Suspect human cases

Prior to the adoption of an active WNV surveillance component, control activities were driven largely by complaints.

3.2.2. Source Reduction Component

The Nassau County program uses source reduction to eliminate mosquito breeding at every level of mosquito production. Inspectors eliminate standing water breeding sources whenever possible during routine complaint investigations. Salt marsh mosquito management involves a program of ditch maintenance to reduce standing water that produces mosquito larvae. Nassau has approximately 1,000 miles of existing ditches, and can maintain 200 miles per year if there are no operational problems. The county has a fleet of 12 specialized vehicles to support this water management component. The Nassau County source reduction component ranks among the best in the northeast, although it relies on ditch maintenance rather than more progressive water management techniques.

3.2.3. Chemical Control Component

There are approximately 70,000 catch basins in the county. Those that are known mosquito larva producers are treated with ALTOSID XR® Briquettes in the spring. These briquettes are intended to provide up to 150 days larval control. If re-treatment is needed during the summer, smaller ALTOSID BRIQUETTES® are used.

On average, the county larvicides approximately 2,000 acres of salt marsh per week, which represents one-fifth to one-sixth of the salt marsh in the county. Larviciding is done with a

contract helicopter applicator, North Fork Helicopters, utilizing *Bacillus thuringiensis israelensis* (*Bti*) (VECTOBAC® granule) in the early season and methoprene (ALTOSID LARVICIDING LIQUID®) later in the season. Approximately 34,000 acres of salt marsh treatments are made annually.

Surveillance triggers may justify the need for adult mosquito control. The Vector Control unit has four London Fogger 18-20 ULV sprayers that are mounted on F350 pickups in August and left on the trucks until the end of the season. Resmethrin (Scourge) is used for truck applications. Adulticide applications are generally restricted to State parks and for salt marsh mosquito control. Salt marsh mosquitoes are normally only treated for in areas south of the Southern State Parkway.

Normally, adulticiding is only done in areas contained by natural barriers. For example, *Oc. Sollicitans* is not normally treated north of the Southern State Parkway. State parks that require adulticiding are treated by NCDPW Vector Control. The trucks used for treatment are driven by DPW inspectors, with a sanitarian riding in the truck to observe the area for citizens and other reasons to interrupt treatment, and to navigate for the driver.

The NCDPW Vector Control Division has 14 pickup trucks and 12 pieces of mechanized equipment. It also has 8 BIRCHMEIER™ and 2 MURYAMA™ backpack sprayers.

Any decision to apply adulticide chemicals is made by NCDH.

3.2.4. Biological Control Component

The Nassau County program realizes the value of introducing fish for mosquito control but maintains a very modest biological control component. Several varieties of predacious fish have been introduced over the years to storm water recharge basins that hold water year round. Most of their efforts involve maintaining habitat for native killifish in salt marsh habitats. Ditch maintenance can encourage survival of native fish.

3.2.5. Educational Component

Nassau County has developed a proactive program for public awareness in mosquito control that reaches a broad range of citizen groups. It provides pamphlets, press releases, and television public announcements with informative messages on mosquitoes, mosquito-borne diseases and elimination of mosquito breeding habitats. Close cooperation between NCDPW and NCDH makes this possible, as the education outreach connects health interests with the applied side.

Continuing education for the mosquito control workers in the county is not emphasized or supported. The county does have an excellent planning regime for the program that encourages teleconferences with state, city and county participants. Some funding to participate in regional and national conferences exists, but is minimal considering the size of the program.

3.3. New York City

The New York City's West Nile Virus program is administered by the New York City Department of Health and Mental Hygiene (DOHMH), Environmental Health, Veterinary and Pest Control.

3.3.1. Surveillance Component

New York City performs surveillance activities for mosquito larvae, adults, and WNV. Larval surveillance provides information on expected adult mosquito density and can indicate areas where efforts to eliminate mosquitoes at their source should be targeted. Adult mosquito surveillance and viral testing provide early predictive information about the potential for a disease outbreak.

Mosquitoes are collected weekly from mosquito traps at 53 permanent locations throughout New York City. In 2003, a total of 145,112 adult mosquitoes belonging to 34 species were tested for the presence of WNV infection. Five mosquito species, *Aedes albopictus, Culex pipiens, Cx. restuans, Cx. salinarius,* and *Cx. territans* were infected with WNV. Of the 7,679 mosquito pools tested, 275 were tested positive for WNV:

- 42 in the Bronx; 37 in Brooklyn

- 11 in Manhattan; 62 in Staten Island

- 123 in Queens.

Cx. pipiens was identified as the primary enzootic vector of WNV from 1999-2003 based upon the number of positive pools.

Mosquitoes are be collected using DOHMH miniature light and gravid traps on a weekly basis. Each trap collection is sorted by species of mosquitoes collected. Information on the location, collection data, trap type and the total number female mosquitoes is recorded. Extra trapping may be conducted to collect day-biting mosquitoes using omni directional Fay Prince traps and mosquito magnets. In the event that pesticides are applied for adult mosquito control, DOHMH will set traps more frequently to evaluate the efficacy of the control measures. Mosquito magnet traps are also used to survey and control adult mosquitoes at wastewater treatment plants.

3.3.2. Source Reduction Component

DOHMH devotes considerable resources to a citywide effort to prevent mosquito breeding, through the aggressive elimination of standing water. Through its public information campaign, DOHMH urges residents to reduce breeding sites around their homes and commercial properties and to report potential mosquito breeding sites. It collaborates with elected officials, other City agencies and large property owners to eliminate standing water in empty lots, tire piles and other containers. DOHMH also aggressively enforces the health code that requires elimination of standing water from properties throughout the City.

3.3.3. Chemical Control Component

DOHMH conducts larviciding in accordance with permits issued by the NYSDEC in catch basins, sewage treatment plants, and areas of permanent standing water. Approximately 135,000 catch basins are inspected and treated at least twice each season by hand application. In areas that are inaccessible by ground vehicles, larvicide may be applied aerially. The larvicides most commonly used in New York City are VectoLex (*Bacillus sphaericus* [*Bs*]), VectoBac (*Bti*), and/or Altosid (methoprene). Catch basin applications are performed by a private contractor

during the summer season. Beginning in May, larvicide is applied at wastewater treatment plants, parks, and other surface waters, if larval breeding is determined to exist.

The DOHMH has acquired a helicopter that will be operated by New York Police Department (NYPD) pilots to perform aerial application of larvicides, as necessary. Currently, aerial larviciding is done under contract by a private applicator.

When warranted, the City will apply pesticides for adult mosquito control. The adulticide used during the last four seasons in New York City is sumithrin (ANVIL®). This product is applied as an ULV application. Applications are generally made with truck-mounted ULV delivery systems. Each spray truck is equipped with a Global Positioning System (GPS) that records the location and time of each spray event. In addition to the driver, who is the certified applicator and employed by the DOHMH, typically each truck has a navigator to assist the driver with safety issues and read maps. While spraying, each truck is preceded by a NYPD vehicle that broadcasts a warning, in two languages, that the area is about to be sprayed for mosquito control. For quality assurance purposes, a private contractor, independent of the pesticide applicator, provides guidance and assists with the technical elements of pesticide application so that operations are conducted according to plan and pursuant to applicable regulations.

Information is released 24 hours in advance of scheduled spray events through the media, the DOHMH web site and WNV Information Line, and pertinent City and community organizations. There have not been any aerial adulticide applications recently. If aerial applications were required, they would be performed by a private applicator under contract to the DOHMH.

3.3.4. Biological Control Component

The City, at this time, does not have a biological control component to their program.

3.3.5. Educational Component

In 2000, DOHMH launched a public education campaign to increase awareness of WNV. This campaign highlighted the need for New Yorkers to take personal protective measures against mosquito bites and to eliminate mosquito breeding sites around their homes. With the theme

Mosquito-Proof NYC, a poster campaign in English and Spanish appeared from May to October in New York City's mass transit system. Similar messages were also aired on television and radio. DOHMH developed 16 fact sheets and made information available in 17 languages to community boards, elected officials, schools, community-based organizations, and the general public. In subsequent years, DOHMH staff has made hundreds of presentations to various community gatherings.

DOHMH receives standing water and dead bird reports via the New York City's Citizen Service Center (311) and DOHMH's enhanced Web site (nyc.gov/health). Callers can receive comprehensive information about WNV, including updated information about adulticiding schedules by dialing 311. The Citizen Service Center provides callers with a live operator 24 hours a day, 7 days a week. DOHMH also provides information on WNV through its web site (nyc.gov/health/wnv) in the form of fact sheets, press releases, adulticiding schedules, and maps. This information is regularly faxed to City agencies, elected officials, community boards, the Department of Education, hospital, nursing homes, associations of green grocers, day camps, and community organizations. DOHMH works with the Department for the Aging (DFTA) for distribution of WNV literature and insect repellents to the senior citizens at social gatherings and formal meetings.

Adulticiding information is made available through DOHMH's web site and phone line, regular news broadcasts, scheduled advertising times on local radio, print media, and web sites of news organizations. Information is released at least 24 hours in advance through the media, DOHMH web site and Citizen Service Center (311), and to hospital emergency departments, pertinent City agencies, elected officials, community boards, the Department of Education, nursing homes, associations of green grocers, day camps, and community organizations.

3.4. New Jersey Mosquito Control Programs

New Jersey mosquito control programs fall into four tiers:

1. Autonomous Mosquito Control Commissions with programs that rank among the best in the nation

2. Mosquito Control Agencies in other units of county government that have maintained excellent programs

3. Mosquito Control programs (Commission or Agency) that have lost staff, lost budget and are in danger of reverting to pest control operations

4. Mosquito Control agencies with model programs conducted by limited staff that require more support to reach their full potential.

Annual budgets in New Jersey range from $2,300,000 to less than $200,000. The autonomous commissions have a maximum budget that is based on tax rateables. Few reach the maximum allowed but pressure put on county boards of Chosen Freeholders (aided by intervention by New Jersey Department of Environmental Protection [NJDEP] and NJAES) can result in higher funding levels when appropriate. All of the autonomous commissions and most of the agencies have a surveillance component that includes larval, adult, and virus surveillance programs. Virtually all of the better programs have a source reduction component that ranges from coordinated tire recycling efforts to major water management programs. The poorer programs rely heavily on chemical control because they lack a comprehensive water management component. Coastal counties, regardless of size, engage in Open Marsh Water Management (OMWM) for salt marsh mosquito control, augmented by funding from the state in many cases. Meetings called by NJDEP and NJAES with county officials have generated significant upgrades in several of the poorer programs in recent years.

The Cape May County Mosquito Extermination Commission and the Monmouth County Mosquito Extermination Commission stand out as New Jersey's premier mosquito control programs. Both have Ph.D., M.S., or M.P.H degreed individuals directing the surveillance and water management aspects of the programs. Both have full-time pilots on staff and own helicopters. The Cape May County program has an accredited Biosafety Level 3 (BSL-3) laboratory on site for research and virus testing purposes. The Monmouth County program is developing a BSL-3 laboratory at Rutgers University that is staffed entirely by Monmouth County personnel.

The Middlesex County Mosquito Extermination Commission, Ocean County Mosquito Extermination Commission, and Morris County Mosquito Extermination Commission rank almost as high. Their mosquito control efforts are comparable to the premier programs, but lack the facilities and personnel needed to conduct laboratory research. Bergen County, Atlantic County, and Essex County had Mosquito Commissions that were abolished, with responsibilities transferred to county Departments of Public Works. Although each has been able to maintain a viable program, improvements can be made. Two obvious issues are:

1. Obtaining permission to leave the county and attend regional and national meetings.

2. Replacement of retiring staff with individuals lacking appropriate qualifications.

Both represent threats to maintenance of the mission and application of the science needed to run a responsible mosquito control initiative.

Regardless of size or funding, the New Jersey mosquito control community has resources provided by the New Jersey State Mosquito Control Commission (NJSMCC) and Rutgers University that are not available in other northeast US jurisdictions. NJSMCC operates the New Jersey State Airspray Program as a service to counties that can document the need for larviciding or adulticiding over significant mosquito breeding acreage. NJSMCC uses capital funds to support an equipment program that provides equipment ranging from rotary ditchers and long-reach cranes to ULV sprayers and microscopes to any mosquito control agency in the state that secures permits to conduct large scale mosquito control projects. NJSMCC supports a cooperative Biocontrol Program with New Jersey Fish and Game to supply insectivorous fish to any mosquito control agency that can document the need. NJSMCC funds Rutgers University to coordinate a virus surveillance program, and reimburses the New Jersey State Department of Health for all virus tests conducted on specimens collected by mosquito control agencies in the state.

Rutgers University offers a 14-week course in Mosquito Identification and Habitat Recognition. The certification program taught at Rutgers includes 3 major teaching components:

1. Lectures on basic mosquito biology

2. Laboratory identification of larvae and adults to species

3. Eight all-day field trips to representative mosquito breeding habitats.

A properly identified larval and adult collection is required. Certification from Rutgers University is granted to those that can pass a rigorous written test and lab practicum at the end of the course. Rutgers University reviews the annual plans and estimates of the New Jersey programs and provides scientific input for budget reform in terms of constructive criticism to the legislators that fund each program. Most importantly, the New Jersey mosquito control community has been meeting monthly at Rutgers University since the 1930s to exchange ideas, receive scientific updates, and compare notes on the best way to accomplish mosquito control properly.

3.5. Connecticut State Program

The Connecticut Mosquito Management Program (MMP) is a state-level multi-agency program. The three main players are the Department of Environmental Protection (CDEP), the Department of Public Health (CDPH) and the Agricultural Experiment Station (CAES). Additional assistance is also obtained from the Department of Agriculture (for domestic animal testing) and the University of Connecticut (UConn) for pathology work on birds and animals.

3.5.1. Surveillance Component

The CAES does all of the mosquito surveillance and testing. Currently, they place carbon dioxide baited traps and gravid traps at 91 locations throughout the state. Additional traps will be placed if virus activity is observed. The trap sites were chosen based on historic virus activity (EEE and WNV) and/or habitats that support vectors of these diseases. Traps are run throughout the summer from June through October, or later if samples indicate virus activity. Each trap is sampled approximately once every seven to ten days. The CAES collects, identifies and tests all the mosquitoes, by species in "pools" of up to 50 individuals each, for a number of viruses. They also do the majority of larval identification, with CDEP performing a portion as well.

The CDPH performs human and avian surveillance. They have an agreement with the CDEP Wildlife Division to hire couriers to collect and deliver dead birds from the local health departments to the state laboratory. They have microbiologists and epidemiologists on staff that commit up to 50 per cent of their time to WNV/EEE work. They also fund laboratory technical assistance at UConn as well as supplies, equipment and transportation.

3.5.2. Source Reduction Component

CDEP does OMWM for mosquito control as part of their larger Integrated Marsh Management (IMM) program of source reduction and restoration/enhancement of degraded wetland. This includes not only OMWM, but tidal flow restoration, culvert replacement, fill removal and similar operations. Approximately 200 to 300 acres of water management is performed per year, with that number increasing to 600 acres if invasive plant control is included.

3.5.3. Chemical Control Component

Connecticut uses between 1,000 and 2,000 pounds of Bti and Bs per season along with methoprene (Altosid) briquets (30 and 150-day) and methoprene granules (30-day) in salt marshes and freshwater wetlands and floodwater areas (in response to complaint calls). The methoprene usage is a few hundred pounds per season. Currently, all applications are done by hand. Investigations are underway for the use of aerial larviciding of Bti, which may be utilized in the future depending on budget constraints. The larviciding is done on the 6,000 acres of state-owned coastal marsh that is routinely inspected. Generally, 500 to 1,000 acres of the marshes are treated in a season.

Catch basin treatments are not performed at this time at the state level unless there is a public health emergency and the larviciding of catch basins is needed in addition to adulticiding. There are, however, a number of towns and private applicators that treat catch basins as part of their local programs, generally with methoprene briquets (Altosid).

Table 1 lists the application rates reported by towns which had state permits for the application of methoprene, for the calendar years 2003 and 2004. Some municipalities apply chemicals with their own forces, but the majority contract out this service to private applicators. The state does

not issue permits for the application of biological larvicides, such as Bti and Bs, and does not maintain records on the use of these agents at the local level.

Table 1 - CT Methoprene Permits

TOWN	2003 (lbs)	2004 (lbs)
Bethel	205	200
Bridgeport	177	
Brookfield	177	
Monroe	18	18
New Haven	1381	1381
New London	145	145
Ridgefield	280	280
Shelton	225	225
Weston/Westport	347	
Wilton	275	275

Note: Values are for pounds of Altosid Briquets (methoprene), not active ingredient

Very little adulticiding is done at the state level. Sites that are treated include state parks along the coast for salt marsh mosquito control. All applications are by truck-mounted ULV, with resmethrin (Scourge®) being the chemical of choice. Aerial application of adulticides has not occurred since 1996 in response to EEE in the southeastern part of the state.

3.5.4. Biological Control Component

The Connecticut State program does not have a biological control component, but they will provide technical assistance to homeowners who wish to use mosquito fish in aquatic gardens.

3.5.5. Educational Component

The CDEP, CAES and CDPH each have websites that contain information on mosquito control and also publish informational brochures. The CAES and CDEP also participate in periodic field days, and have displays at fairs and other public events. CDEP has also developed Public Service Announcements that go out on public access cable and has done local television and radio spots.

The CDEP Wetland Habitat and Mosquito Management Program also provides technical assistance to municipalities and the public on mosquito control. They respond to complaint calls and provide recommendations to abate mosquito problems to local health departments, public works departments, and licensed private applicators.

4. Outside Review of Suffolk County Department of Public Works Division of Vector Control

The Suffolk County Vector Control Program (SCVC) operates under New York State Public Health Law and Article 15 of the Suffolk County Charter. Its responsibility is to control mosquito infestations that threaten public health or create social or economic problems for county residents. The Division has their offices in Yaphank with a staff of 50 full time employees. The total operating budget is approximately $2,700,000.00 at the present time.

SCVC works closely with the Suffolk County Department of Health Services (SCDHS), which operates an Arthropod-Borne Disease Laboratory at the Yaphank facility. This relationship assures ongoing health related surveillance input for SCVC vector control decisions. Additional cooperative working relationships exist between SCVC and the New York State Department of Health.

Suffolk County has a population of 1,500,000 within a land mass of 912 mi^2. The county ranges from urban through suburban to rural in terms of population density, which increases the range of mosquito habitats that must be monitored. Salt marsh floodwater, fresh floodwater and permanent swamp mosquito breeding habitats must be dealt with in addition to a wide variety of habitats that produce domestic mosquito species. A total of 42 different mosquito species have been identified since the program was developed to combat malaria during the 1930s.

Suffolk County has an ongoing threat from mosquito-borne diseases that includes EEE as well as WNV. Although WNV has received considerable publicity in recent years, EEE must be closely monitored because Suffolk has all of the ingredients for transmission to humans. Significant *Culiseta melanura* habitat (the amplification vector) is present at a number of inland foci that must be monitored for evidence of virus activity. Coastal salt marshes produce large populations of *Oc. sollicitans*, an extremely efficient vector of this virus and a documented bridge vector to humans. Inland areas have habitat for *Cq. perturbans*, a secondary bridge vector for the virus, that requires specialized larval surveillance techniques. Monitoring efforts for both EEE and WNV are required over the course of every mosquito breeding season.

Surveillance Component

SCVC directs considerable resources towards surveillance. A large proportion of its permanent staff positions have surveillance obligations to assure that surveillance data guides the control decisions. The wide variety of mosquito breeding habitats in Suffolk County requires an in-depth larval surveillance component. Teams of inspectors are assigned to geographical areas of the county to guarantee complete coverage of potential breeding habitats on a regular basis. Records are kept on a wide variety of parameters that make up each of the breeding sites that the inspection team is responsible for. Larval surveillance results are quantified by the inspectors in the field to give an overview of population density prior to the initiation of larval control. SCVC identifies a large proportion of the field material collected by its inspectors to species and has laboratory space devoted specifically to that activity. Very few mosquito control agencies in the northeast have surveillance programs of this scope.

Adult surveillance is accomplished by identifying trap catches from 27 permanent NJ light trap stations in the county. The adult surveillance data set is analyzed by location, trap night, species, and male to female ratios in the collections as well as the percentage of saltmarsh or freshwater species that are represented in the data set. Year-to-year as well as week-to-week comparisons can be made to provide a complete picture of how current populations deviate from long-term means. Such surveillance ranks among the best in the nation.

Virus surveillance is directed against a broad scope of lesser known mosquito-borne arboviruses as well as the primary risk targets, EEE and WNV. As with most virus surveillance programs in the northeast, bridge vectors are sampled with CDC traps baited with CO_2. *Culex* species that function as amplification vectors are captured in gravid traps baited with an oviposition attractant. Specimens for virus testing are sorted and identified to species at the Arthropod-Borne Disease Laboratory. The specimens are pooled and sent to Albany for tests. Turn around time for this process poses a problem for SCVC. Virus surveillance results can be up to two weeks old by the time they are received, suggesting that in-house testing would provide substantial improvements. The Arthropod-borne Disease Laboratory is experimenting with the Rapid Analyte Measurement Platform (RAMP) system to test specimens in house to shorten turn around time. It is also developing a system to use Polymerase Chain Reaction (PCR) to become

completely independent but needs more staff to make this aspect of the cooperative program fully operative.

SCVC uses a number of additional surveillance tools to broaden the scope of information that goes into their vector control decisions. Over the years these have included landing rates, bite counts, resting boxes, and sentinel chickens, as well as an integrated Geographical Information System (GIS) to map complaints into the overall surveillance database and track the responses.

Source Reduction Component

The SCVC comprehensive program for water management ranges from simple sanitation to broad scale water management programs. A work force of 40 individuals is utilized for this aspect of the work. Hand labor aspects of their program include hand ditch maintenance, de-snagging, and stream clearance projects. SCVC does not have an organized tire removal initiative.

SCVC has an inventory of high-tech water management equipment for major projects that includes two amphibious rotary ditchers and a Bombardier GT-300 multipurpose track vehicle fitted with a dump body to facilitate moving spoil. The program also maintains a low ground pressure excavator that permits water management in sensitive areas with minimal disturbance to wetlands habitats. The superintendent of this program has a background in water management, which provides SCVC with the expertise needed for water management planning as well as the implementation of projects. The program uses GIS as well as GPS technology to maximize their resources to the areas where water management is most beneficial. A biologist and GIS technician are on staff to assure that the source reduction component operates efficiently. The water management staff ranks among the best on a national scale.

One shortfall in the SCVC source reduction component is the inability for this program to utilize its water management expertise where the benefits are most needed. There is opposition to water management in areas of salt marsh within the county that chronically breed mosquitoes. In some cases, SCVC is prevented from cleaning grid ditches that should have been replaced by OMWM years ago. It is not good mosquito control policy to allow ditches to re-vegetate without a system

in place to eliminate breeding habitat produced by the resulting stagnation of water flow. The situation is compounded by the fact that larval control is not permitted on federal lands on Fire Island and the William Floyd Estate. This unfortunate set of circumstances forces SCVC to rely on adulticiding to reduce annoyance and vector potential from broods of salt marsh mosquitoes that emerge at regular intervals during the course of the mosquito season.

Chemical Control Component

During the summer, SCVC conducts a weekly survey of over 100 wetland breeding sites, mostly salt marsh, that are too large for ground application of larvicides. Based on the results of that survey, decisions are made as to which areas are to be treated and with what material. A contract helicopter makes the application, usually the day after the survey, using material provided by SCVC. The decision to treat, and the material to use, is based on the presence of larvae, tidal stage, degree of flooding, time of year, and larval stages present. In general, liquid Bti is preferred when first and second instars are detected early in the season, and when the marshes are well flooded. Third and fourth instars, and all stages in mid-summer, are treated with methoprene (ALTOSID® LIQUID CONCENTRATE). When all larval stages are present, both larvicides may be used in a tank mix. There are about 3000 acres of breeding habitat in the aerial larvicide program, and these major areas account for approximately 90 percent of all larvicide treatments.

In 2004, more acres were treated with *Bti* than with methoprene. The location and time of all applications is recorded on a GPS and the information is downloaded and permanently stored. The attention to detail and success of the aerial salt marsh larviciding program contributes greatly to minimizing the number of adult mosquitoes that move inland. The net result is less use of adulticides and lower risk of disease transmission to people and equines.

In addition to the aerial larviciding program, inspection crews carry larvicide products in back pack and hand held sprayers on their vehicles. The products available for use are *Bti* liquid, ALTOSID® Liquid Larvicide, VectoLex® Granules, and ALTOSID® XR Briquets (that are applied to catch basins). Approximately 5,000 of the estimated 100,000 catch basins in the county are treated. Inspection crews only apply larvicides if larvae are present.

If adults emerge, and the surveillance program indicates that they may pose a threat to the human population, adulticiding programs may be utilized. Ground adulticiding is performed by the field crew on an overtime basis. The equipment used are truck-mounted London Fogger ULV sprayers that dispense approximately one ounce of formulated insecticide per acre. These sprayers are equipped with Monitor III™ systems which monitor the amount of pesticide being applied at all times, and, with the attached GPS, keep an accurate record of the time and location of all applications. Resmethrin (SCOURGE® 18-54) is the adulticide typically applied, with sumithrin (ANVIL® 10+10) used secondarily. The amount of active pyrethroid applied per acre is in the range of 0.0017 to 0.007 pounds of resmethrin per acre for the pesticide SCOURGE® 18-54 or 0.0012 to 0.0036 pounds of sumithrin for the adulticide ANVIL® 10+10. The sprayers are calibrated to dispense very precise amounts of pesticide. Accurate records of the type of pesticide used, the amounts used, and the location of the treated areas are maintained and forwarded to state regulators. In 2004, there were two aerial adulticide applications. There were three applications in 2002 and 2003.

Periodically, SCVC and outside organizations examine the spray equipment to ensure it is applying the proper amount of pesticide and is generating the correct droplet size as specified on the label. The droplet size spectrums for these two products are: ANVIL® 10+10 – Mass Medium Diameter (MMD) of five to 25 microns, and SCOURGE® 18-54 a MMD of eight to 20 microns. SCVC has its own DC-III droplet analysis unit, which is used for both ground and aerial ULV applications. They also have the ability to do slide analysis for droplet size. These droplets sizes ensure optimum movement through the flying adult mosquito population and ensure the droplets will impinge on the flying mosquitoes. The relatively small droplet size also tends to protect larger insects because the low amount of insecticide per droplet will not normally have any effect on larger insects, birds or mammals. These two insecticides are the same products used by adjoining and neighboring mosquito control agencies.

Biological Control Component

SCVC does have a fish-stocking program. Natural populations of *Gambusia affinis* are found in some areas of the county and the fish are often moved to areas where they can have an impact on mosquito breeding habitat. The Arthropod-Borne Disease Laboratory at the Yaphank facility

assists in this portion of the program by obtaining the necessary permits. Stocking is conducted by field crews, most often on the basis of complaints. In 2004, SCVC stocked ponds in Lindenhurst, Amagansett, Bellport, Flanders, Amityville, and Brookhaven.

Educational Component

SCVC maintains an advanced public outreach program. Inspectors deal directly with property owners when they respond to resident complaints. SCDHS has taken the lead role in public education, and has an educator on staff to coordinate the effort. Sanitarians are used to enforce property cleanups of mosquito breeding problems when they are needed. Public education includes distribution of pamphlets, media exposure, and presentations to citizen groups. SCDHS also has a web site with a wide variety of information on mosquito control. One major public education component is public notification and the no-spray registry. Public notification is a major undertaking that includes no-spray maps, media posted spray schedules, a 24-hour hot line, and the county's reverse E911 system.

SCVC is less advanced in the continuing education component of their program. In-house training for pesticide license recertification renewals is coordinated through Cornell University. Attendance at scientific meetings by professional staff is less well supported.

4.6 Comparison of SCVC with other Mosquito Control Programs in the Northeast.

Table 2 compares aspects of the SCVC program with Nassau and Westchester County programs and 16 of New Jersey's 21 mosquito control commissions/agencies. Table 3 compares these programs on the basis of IPM components, and Table 4 offers a comparison of budgeted funds expended per square mile of area and per person in the respective counties. Table 4 indicates that Suffolk County, although operating a well-respected mosquito control program, expends less per land area, and per person, than many of the New Jersey programs.

In terms of the New York programs, SCVC is superior by the criteria NJAES uses to evaluate professionalism in mosquito control. The Westchester county program is essentially a WNV control program and lacks many of the components needed to drive a responsible mosquito

control effort. Although the program is evolving, it cannot compare with the balanced SCVC approach to mosquito control. Nassau County has an excellent mosquito control initiative, tailored to mosquito control in an area of high population density. As with Suffolk County, the Nassau County program is situated within the DPW but has an excellent working agreement with its Health Department which provides services to the citizenry that could not be otherwise provided. The urban setting allows it to focus on a smaller range of pests and vectors, which makes its' job simpler than that of SCVC in terms of habitats that require monitoring. Nassau, like Westchester, does not have extensive tidal wetlands near major population centers as are present in Suffolk County. Nassau County is much smaller than Suffolk County in terms of land area, which minimizes travel for both surveillance and control. The Nassau County program has allowed the NCDH to assume much of the science, allowing the mosquito unit to focus on and excel in the applied aspects of mosquito control. Technologically, SCVC is proactive while Nassau relies heavily on its Health affiliate to provide technological skills. SCVC personnel appear better qualified, better trained, and more diverse than their Nassau counterparts. Surveillance complements the Nassau County program but does not drive its overall control efforts. SCVC has one of the best surveillance programs in the country and stands out in that regard. The working relationship that SCVC has with SCDHS allows it to conduct research to support its mission, which is rare in most mosquito control programs.

In comparison with the NJ programs, SCVC ranks high but does not lead. SCVC certainly has a more complete program that any NJ county that has a mosquito control program in DPW setting. The SCVC program exceeds any NJ agency program by a very wide margin. Its close affiliation with Health Services is one important reason, but overall the level of professionalism in the SCVC program allows them to provide services well beyond the norm.

To the credit of Suffolk County, SCVC would be ranked higher by NJAES criteria than six of NJ's eight autonomous commissions. The SCVC surveillance program provides a model that few NJ programs can match. SCVC understands mosquito control and the integration of components that provide for responsible mosquito management. The SCVC budget is also a factor because it gives it the tools to excel. However, the counties of Cape May and Monmouth in New Jersey have developed better programs with lower budgets for several important reasons.

The political structure in Cape May and Monmouth Counties, using commissions, promotes better expenditures of funds. Monetary decisions are made by citizens that are appointed as commissioners, and who also have input from a University. The political structure of a commission allows the commissioners to hire trained professionals when needed, rather than have training develop on the job. Rutgers University has instilled the concept that mosquito control should be based on science. This allows the hiring of students trained in mosquito biology at the Masters and Ph.D. levels. Virtually all of NJ's commissions and a large proportion of the agencies have adopted that philosophy, allowing for a high level of professional support. It is not uncommon to see individuals with Masters degrees in biological or administrative positions. New Jersey's programs almost all have better continuing education programs, promoting participation in state and regional meetings to encourage technical proficiency, which directly upgrades the quality of programs. The lack of such support is a significant deficiency for SCVC.

Suffolk County once led the northeast with their excellent source reduction component. The quality of equipment available to the program shows that water management is taken seriously. NJAES, however, would point out two serious shortcomings in the current SCVC source reduction component:

1. The lack of an organized tire reduction program

2. The inability to engage in meaningful water management to reduce populations of salt marsh mosquitoes on federal lands.

The fact that SCVC does not have an organized tire pickup program at the present time should be addressed. Tires provide breeding habitat for the major mosquito vectors of WNV. SCVC should take the lead in a meaningful tire removal initiative to show the general public how simple sanitation contributes to mosquito control and reduction in disease potential. Most mosquito control agencies in the country engage in this relatively simple form of source reduction for mosquito control. The public relations benefits alone make this a worthwhile activity that can be achieved at relatively low cost.

An inability to address major breeding areas in proximity to residential areas is an obvious deficiency for a mosquito control program. There is no obvious solution to this situation, which is caused by federal policies long established and validated nationwide for national parklands and designated wilderness areas.

In addition, the problems SCVC is having enacting OMWM in salt marshes seriously interferes with its ability to provide responsible mosquito control. Well-designed water management projects are essential for mosquito management and should be integrated into the SCVC effort. New Jersey's coastal counties have all developed well funded, progressive OMWM programs that have significantly reduced pesticide usage and eliminated chronic breeding habitats. Suffolk County is currently caught in controversy that is increasing rather than decreasing its reliance on pesticides. NJAES would issue harsh criticism to those who oppose water management programs, and would insist that a solution be found. Suffolk County has the potential to have one of the best mosquito control programs in the country. The funding levels are more than adequate to achieve that status if the few drawbacks could be overcome.

Table 2 - Comparison of Selected Mosquito Control Agencies in the Northeast

County	Land Area	Population	Full Time Employees	Seasonal Employees	Approximate Operating Budget
New York State Programs					
Suffolk	912 mi^2	1,500,000	50		$2,700,000.00
Nassau	287 mi^2	1,400,000	20	6	$1,200,000.00
Westchester	500 mi^2	925,000	7	4	(Not Available)
Premier NJ Programs [1]					
Cape May	267 mi^2	665,000	18	13	$2,300,000.00
Monmouth	472 mi^2	650,000	25	12	$2,300,000.00
Middlesex	318 mi^2	775,000	20	7	$1,700,000.00
Ocean	640 mi^2	480,000	15	12	$1,600,000.00
Morris	479 mi^2	470,000	24	3	$2,300,000.00
Remaining NJ Programs [2]					
Bergen	246 mi^2	885,000	27		$1,300,00.00
Atlantic	567 mi^2	255,000	11	3	(Not Available)
Essex	127 mi^2	780,000	23	As Needed	$1,900,000.00
Warren	365 mi^2	103,000	7	4	$ 600,000.00
Camden	221 mi^2	515,000	15		$ 675,000.00
Mercer	226 mi^2	360,000	10	0	$ 540,000.00
Salem	338 mi^2	65,000	8	1	$ 520,000.00
Hunterdon	430 mi^2	126,000	2	3	$ 150,000.00
Gloucester	328 mi^2	250,000	9	0	
Passaic	195 mi^2	500,000	15		$ 680,000.00
Sussex	535 mi^2	144,000	4	2	$ 250,000.00

[1] Ranked by NJAES criteria

[2] Figures not included for Union, Somerset, Burlington, Cumberland and Hudson Counties in New Jersey

Table 3. Comparison of SCVC with Other Programs in the Northeast in Terms of IPM Components

PROGRAM	Surveillance	Source Reduction	Chemical Control	Biological Control	Educational
New York Programs					
SCVC	Larval, adult and virus surveillance are among the best in the nation with excellent cooperation with SCDH, Most importantly, SCVC uses the information to make responsible control decisions.	Maintains an inventory of high tech equipment for use on major water management projects. Possesses the ability to excel at the national level in this category. Opposition to management on salt marshes increases the need for chemical control and detracts from how SCVC would be ranked in this category.	Well equipped to conduct meaningful chemical control. Has developed a meaningful list of triggers to assure that all control decisions are justified. Ranks among the best in the northeast in this important category.	Maintains an adequate fish stocking program based on confirmed complaints. Would not be considered a leader in this area without increasing their efforts markedly.	Maintains an advanced public outreach program with an educator on staff. Good in-house training but limited support for professional education of most of the staff. Limited attendance at scientific meetings detracts from the programs image at the national level, and limits up-to-date access to knowledge of many SCVC key personnel.
Nassau	Strong larval, adult and virus surveillance conducted in cooperation with NCDH.	Excellent source reduction at every level of mosquito production.	Well equipped to conduct meaningful larval and adult control.	Limited primarily to maintaining habitat for native killifish in salt marsh habitats.	Proactive program for public awareness. Limited support for professional education of most staff.
Westchester	Limited to WNV. Not used to drive control aspects.	Limited to monitoring catch basins. Lacks equipment to conduct water management.	Limited to larviciding catch basins. No equipment for adult control.	None in place.	Excellent public education component. Limited funds for professional education of all but the key staff.

New Jersey Programs	Surveillance	Source Reduction	Chemical Control	Biological Control	Educational
Autonomous Commissions with Premier Programs	Exceptionally strong larval, adult and virus surveillance with dedicated space and staff for each component.	Excellent source reduction at every level of mosquito production, with well a trained water management specialist in charge.	Exceptionally strong chemical control component with both aerial and ground equipment, relying heavily on surveillance data to trigger responsible control decisions.	Take full advantage of the State Biocontrol Program. Promote biological control as a part of their public relations activities.	Excellent public relations component with a Biologist usually in charge. Funds are made available for professional education and professional staff are routinely sent to scientific conferences.
Agencies in Units of County Government with Excellent Programs	Good larval, adult and virus surveillance with dedicated space and staff for each component.	Excellent source reduction at every level of mosquito production, often relying on State Equipment Program to complete necessary tasks.	Utilize larval and adult control components of their program responsibly. Make frequent use of the State Airspray Program for many control activities.	Routinely use the state Biocontrol Program to stock mosquito eating fish.	Maintain a good program of public education. Provide in-house professional education, but rarely send their staff to any out-of-state educational meetings.
Agencies with Model Programs that require more support	Excellent larval, adult and virus surveillance using staff with other responsibilities.	Lack both personnel and equipment to conduct meaningful water management projects.	Maintain a modest program of larval and adult control. Recruit administrator and biologists frequently and rely heavily on seasonal help.	Incorporate a Biocontrol component into their program, primarily for public relations purposes.	Maintain a modest public education program. Routinely provide key staff with funds to attend educational meetings.
Programs in danger of reverting to Pest Control Operations	Little or no larval surveillance, modest adult surveillance. Information is rarely available to help make responsible control decisions. Work often performed by poorly trained seasonals.	Most do not engage in the source reduction aspects of mosquito control.	Rely too heavily on the chemical control component to keep mosquito populations manageable.	Rarely engage in biocontrol aspects of mosquito control even though the service is available.	Have neither a public education or professional education component in their program.

Table 4. Comparison of SCVC with Other Programs in the Northeast in Terms of Cost

County	Land Area	Population	Approximate Operating Budget	Approximate Cost per Square Mile	Approximate Cost per Person
New York State Programs					
Suffolk	912 mi^2	1,500,000	$2,700,000.00	$2,960	$1.80
Nassau	287 mi^2	1,400,000	$1,200,000.00	$4,181	$0.86
Westchester	500 mi^2	925,000	(Not Available)		
Premier NJ Programs					
Cape May	267 mi^2	665,000	$2,300,000.00	$8,614	$3.46
Monmouth	472 mi^2	650,000	$2,300,000.00	$4,873	$3.54
Middlesex	318 mi^2	775,000	$1,700,000.00	$5,346	$2.19
Ocean	640 mi^2	480,000	$1,600,000.00	$2,500	$3.33
Morris	479 mi^2	470,000	$2,300,000.00	$4,802	$4.89
Remaining NJ Programs					
Bergen	246 mi^2	885,000	$1,300,00.00	$5,285	$1.47
Atlantic	567 mi^2	255,000	(Not Available)		
Essex	127 mi^2	780,000	$1,900,000.00	$14,960	$2.44
Warren	365 mi^2	103,000	$ 600,000.00	$1,644	$5.83
Camden	221 mi^2	515,000	$ 675,000.00	$3,054	$1.31

Mercer	226 mi^2	360,000	$ 540,000.00	$2,389	$1.50
Salem	338 mi^2	65,000	$ 520,000.00	$1,538	$8.00
Hunterdon	430 mi^2	126,000	$ 150,000.00	$349	$1.19
Gloucester	328 mi^2	250,000			
Passaic	195 mi^2	500,000	$ 680,000.00	$3,487	$1.36
Sussex	535 mi^2	144,000	$ 250,000.00	$467	$1.74